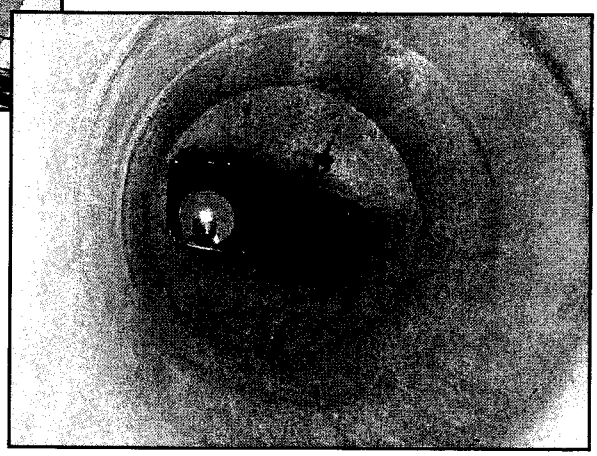
City of Sunnyvale

Sanitary Sewer Flow Monitoring

Site 7: View from Above



Site 4: View into Manhole

September, 2006

V&A

SANITARY SEWER FLOW MONITORING
AND
CAPACITY ANALYSIS

CITY OF SUNNYVALE

Prepared for:

MARK THOMAS & COMPANY
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Prepared by:

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1999 Harrison Street, Suite 975
Oakland, CA 94612

September 2006

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APPENDIX A – Flow Monitoring Sites: Graphs and Figures

INTRODUCTION

V&A was retained by Mark Thomas & Company, Inc., to conduct sanitary sewer flow monitoring at eight manholes in Sunnyvale, California. The purpose of this study was to record the existing flow volumes through the sanitary sewer pipes. The scope of work included the following tasks:

- Install flow monitoring equipment at eight locations to determine the existing sanitary sewer flow. Record flow data for a period of two weeks at 15-minute intervals.
- Provide calculations of the existing sewer pipe capacity.

Flow monitoring was conducted over a two-week period from July 28, 2006, through August 11, 2006, at eight flow monitoring sites. Sites were chosen by Mark Thomas and located as follows:

- **Site 1:** A flow meter was installed in the upstream side of the 27-inch line on Lawrence Expressway at the manhole upstream of the proposed development.
- **Site 2:** A flow meter was installed in the upstream side of the 10-inch line at the intersection of East Duane Avenue and Stewart Drive.
- **Site 3:** A flow meter was installed in the upstream side of the 18-inch line at the manhole in the cul-de-sac at Duane Court.
- **Site 4:** A flow meter was installed in the upstream side of the 15-inch line at the manhole on Duane Avenue just west of the intersection with San Simeon Street.
- **Site 5:** A flow meter was installed in the upstream side of the 12-inch line at the manhole on Duane Avenue just west of the intersection with San Miguel Avenue.
- **Site 6:** A flow meter was installed in the upstream side of the 12-inch line at the manhole on De Gugne Drive at the west to north turn in the road.
- **Site 7:** A flow meter was installed in the upstream side of the 12-inch line at the manhole on De Gugne Drive south of the intersection with Stewart Drive.
- **Site 8:** A flow meter was installed in the upstream side of the 10-inch line at the manhole on North Wolfe Road north of the intersection with East Arques Avenue.

Figure 1 illustrates the locations of the manholes where the flow meters were installed.

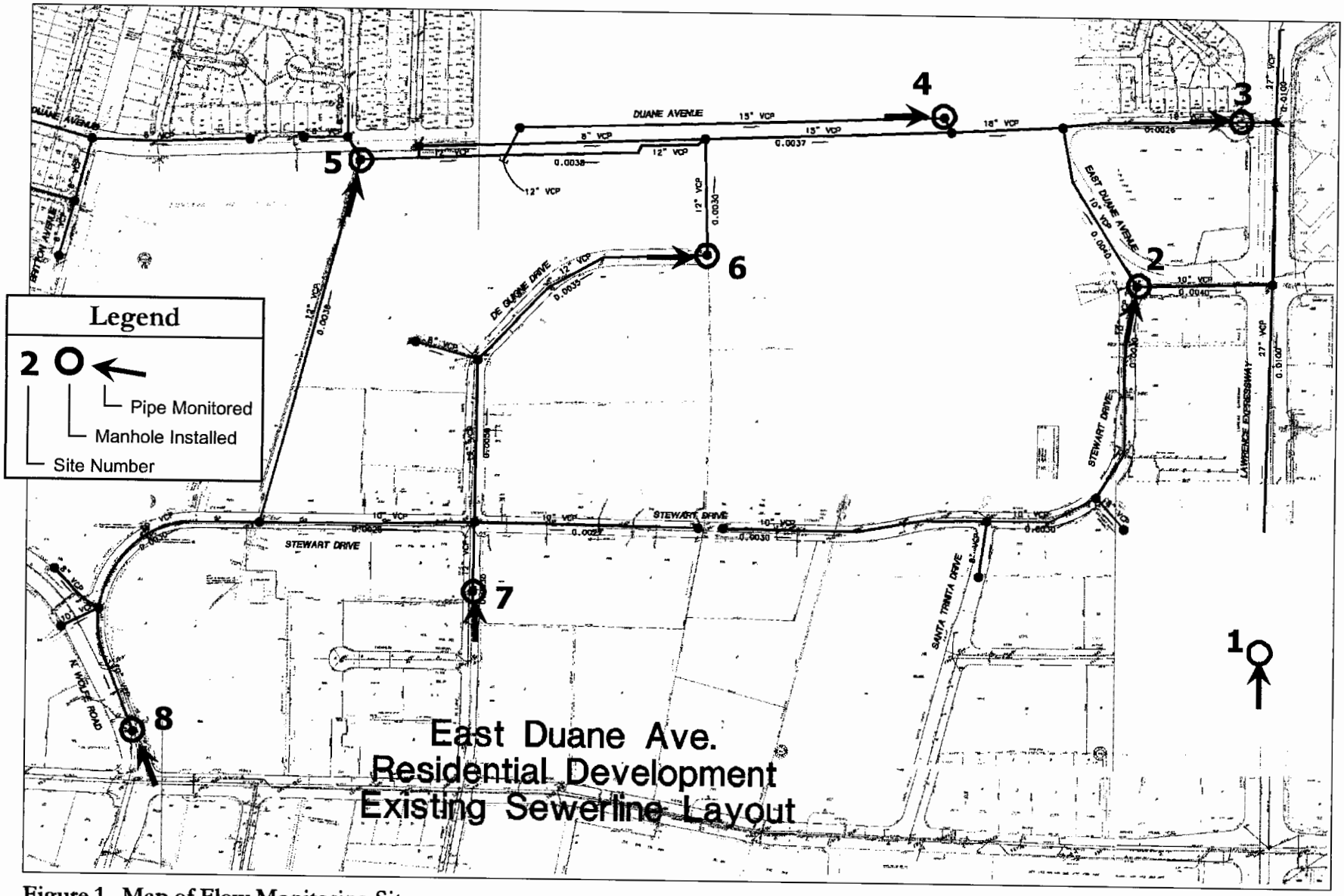


Figure 1. Map of Flow Monitoring Sites

FLOW MONITORING METHODS AND PROCEDURES

Meter Installation

Eight Isco 2150 flow meters were installed by V&A in the sewer manholes shown in Figure 1. Isco meters use a pressure transducer to collect depth readings, and ultrasonic Doppler sensors on the probe determine the average fluid velocity. Figure 2 shows a diagram of a typical flow meter installation.

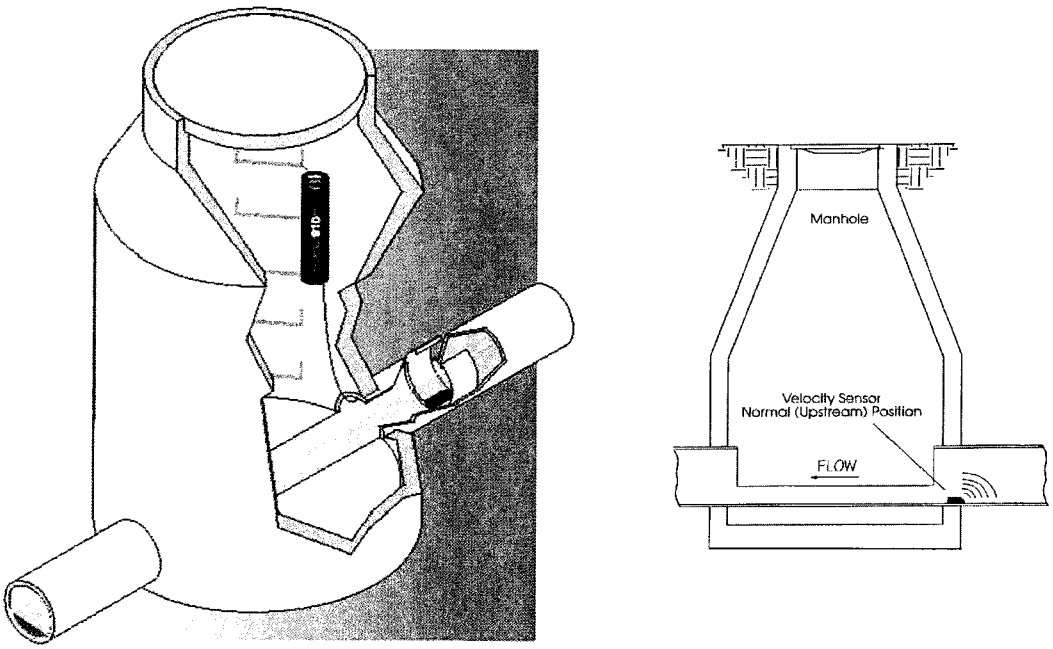


Figure 2. Flow Meter Installation Diagram

Manual level and velocity measurements were taken in the field during the flow meter installation and again when the meters were removed. These manual measurements are compared to the instantaneous level and velocity readings of the flow meter to ensure proper calibration and accuracy. The continuous depth and velocity readings were recorded by the flow meters in 15-minute increments and downloaded into a computer spreadsheet program where the data could be analyzed and made report ready.

Explanation of Report Graphs and Definition of Terms

Flow versus time graphs are created by interpolating the data recorded by the flow meter in 15-minute intervals, and represent the diurnal flow curve recorded over a given monitoring period. These graphs represent the data in its rawest form. Figure 3 shows a typical diurnal flow curve and identified on this graph are the hypothetical peak, low, and average flows recorded over an example monitoring period. These graphs are useful in identifying the extreme limits of the flows being monitored, and identifying any trends that might be occurring at a particular site. Flow, level, and velocity graphs versus time which show the actual recorded data over the monitoring period are provided in *Appendix A* of this report.

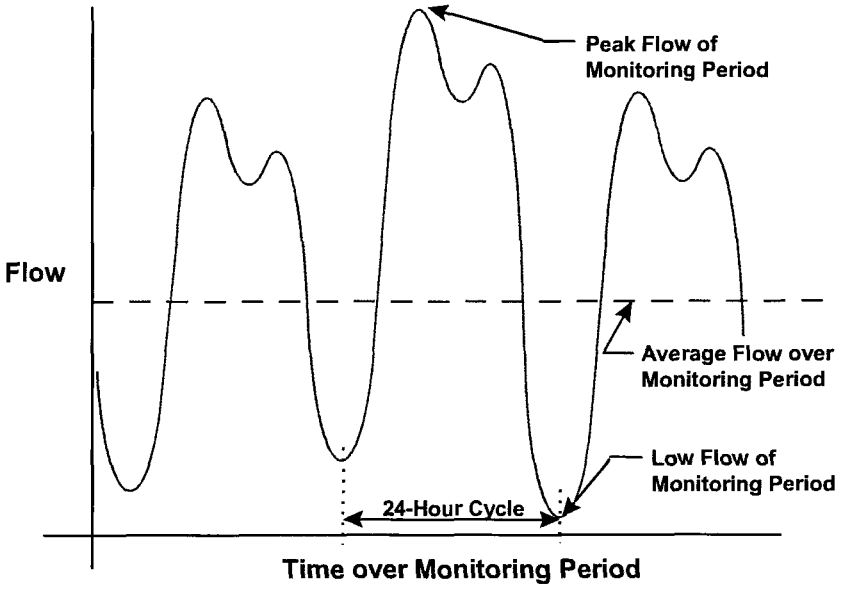


Figure 3. Diagram of Hypothetical Diurnal Flow over Monitoring Period

Dry weather flow is the flow that is caused by actual waste drainage from buildings in the area. Wet weather flow includes rain-dependent infiltration and inflow which may increase the flow through the sewer pipes. The flows recorded during this study were dry weather flows only. For this report, the peak and average flows during dry weather are reported and are abbreviated as such: ADWF for average dry weather flow; PDWF for peak dry weather flow.

FINDINGS

Flow Monitoring Results

Flows were typical of residential areas, with a diurnal curve and expected peaks in the early morning and early evening hours. Weekday and weekend flow patterns vary and must be separated when determining average dry weather flows. Figure 4 plots the average daily weekday and weekend flows for Site 1.

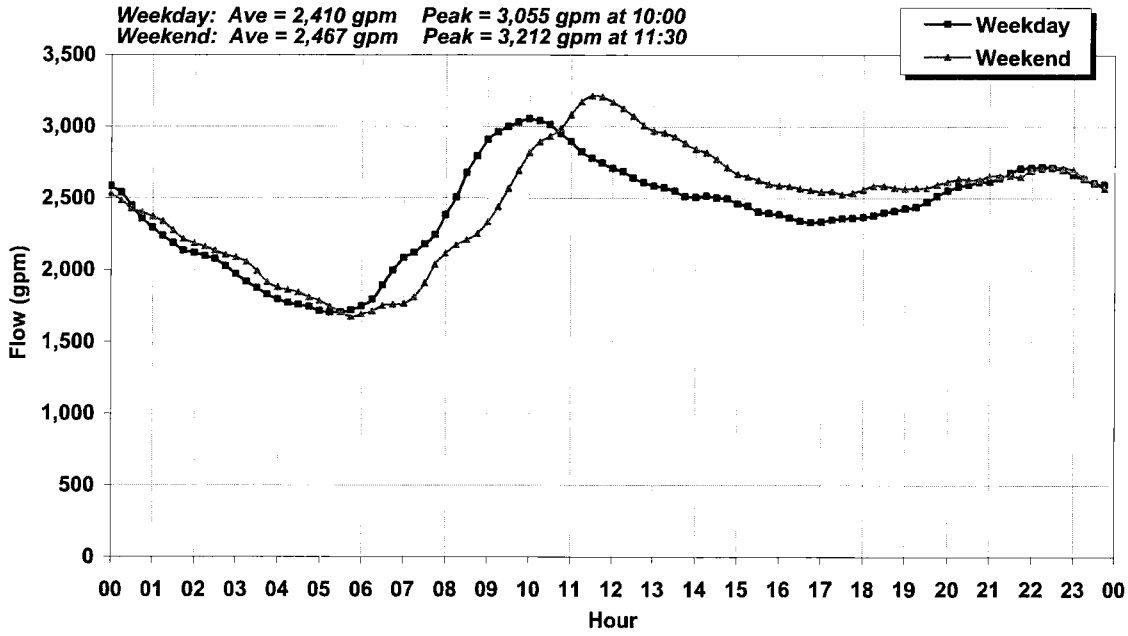


Figure 4. Average Daily Flow Graph (Site 1)

Table 1 summarizes the measured average and peak dry weather flows at the flow monitoring sites during the flow monitoring period. Figure 5 illustrates a flow diagram with average dry weather flow data and pipe snapshots.

Table 1. Flow Monitoring Results

Site	Weekday Average Flow (gpm)	Weekend Average Flow (gpm)	ADWF** (gpm)	Weekend to Weekday Ratio	Peak Measured Flow (gpm)	Peak to ADWF Ratio
Site 1: 27-inch Line	2,410	2,467	2,426	1.02	3,407	1.40
Site 2: 10-inch Line	89	67	83	0.75	215	2.60
Site 3: 18-inch Line	590	577	586	0.98	730	1.25
Site 4: 15-inch Line	27	25	27	0.91	90	3.39
Site 5: 12-inch Line	43	41	42	0.96	67	1.60
Site 6: 12-inch Line	269	263	268	0.98	367	1.37
Site 7: 12-inch Line	15	9	13	0.61	44	3.36
Site 8: 10-inch Line	5	4	5	0.97	11	2.54

**ADWF calculated as (5*weekday+2*weekend)/7

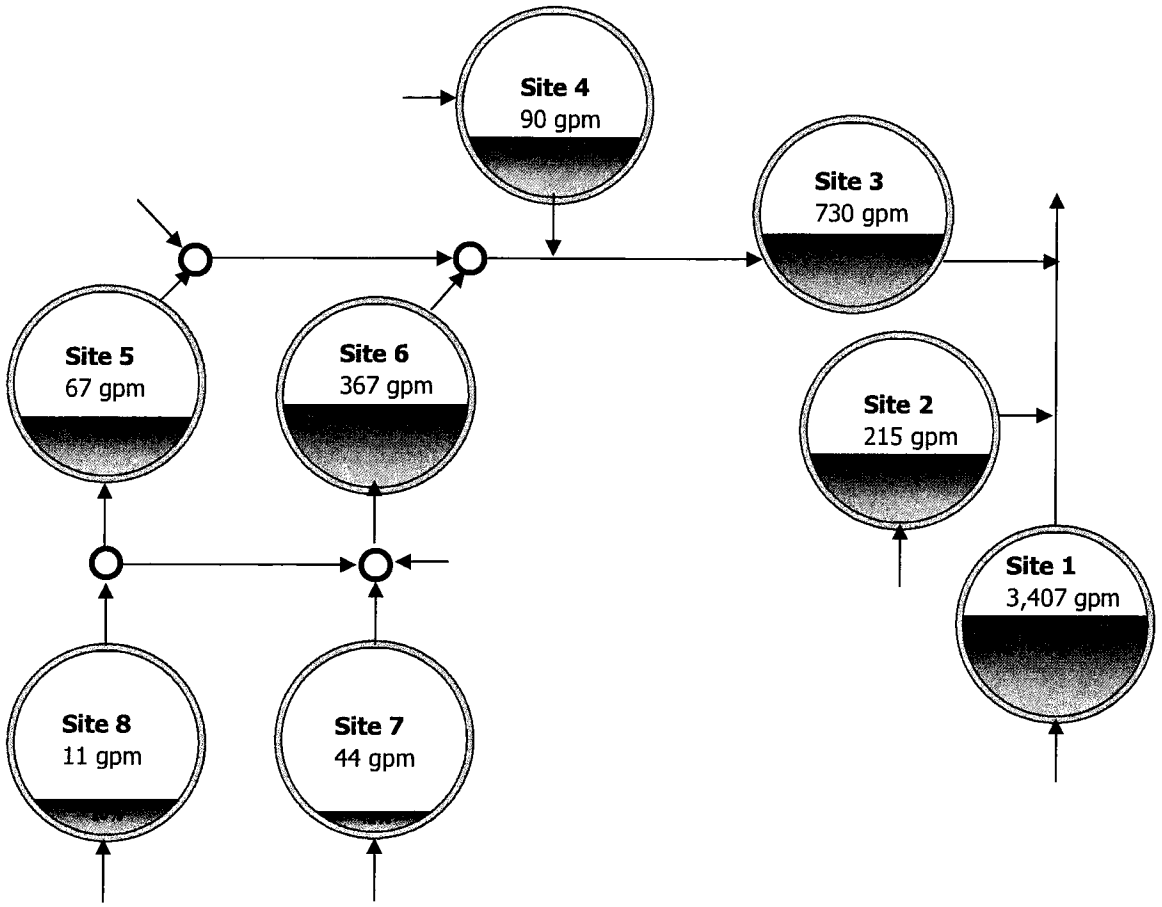


Figure 5. Peak Measured Flow Diagram of Monitoring Sites

Plots summarizing the flows at each of the monitoring sites are shown in *Appendix A.*.

APPENDIX A

FLOW MONITORING SITES: GRAPHS AND FIGURES

Site Information Report

Monitoring Site: Site 1

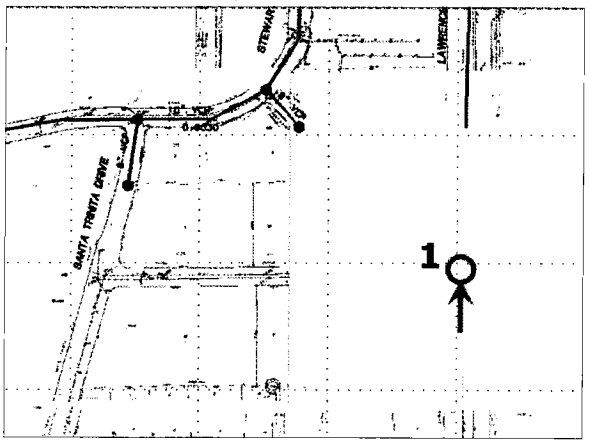
Location: Leftmost northbound lane of Lawrence Expressway
Traffic: Heavy traffic at high speed with breaks due to traffic signal

Diameter: 27 inches
Pipe material: VCP

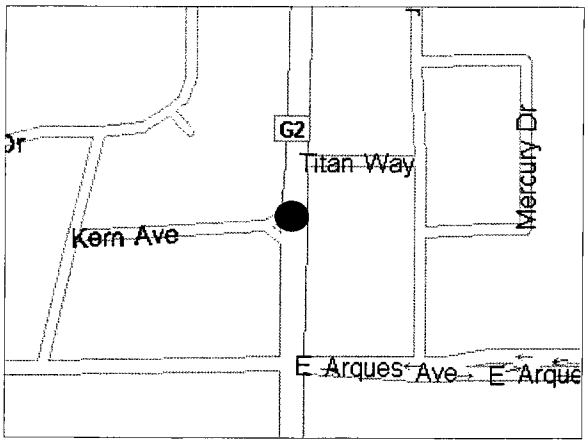
Average Dry Weather Flow: 2,426 *gpm*
Peak Measured Flow: 3,407 *gpm*

Sites upstream from this site: None

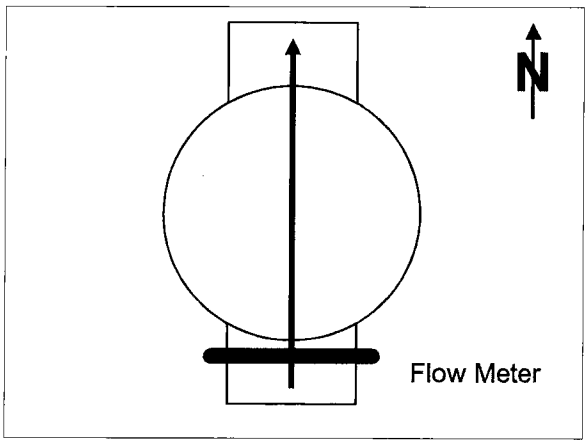
Sanitary sewer map:



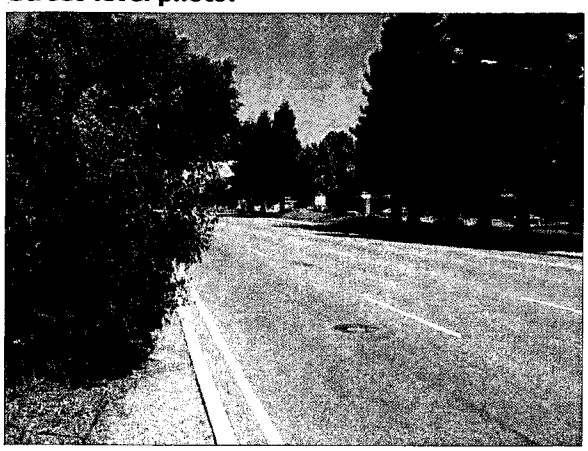
Street map:



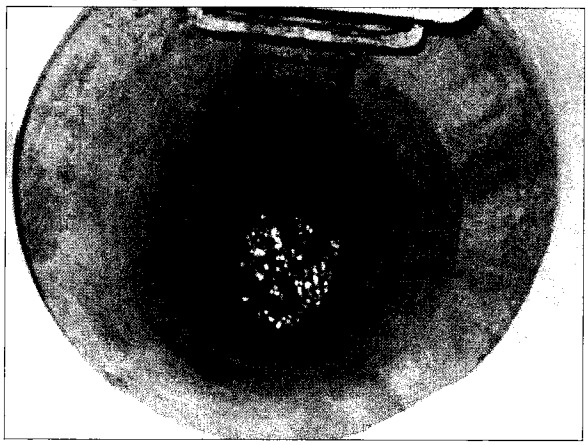
Flow sketch:



Street-level photo:



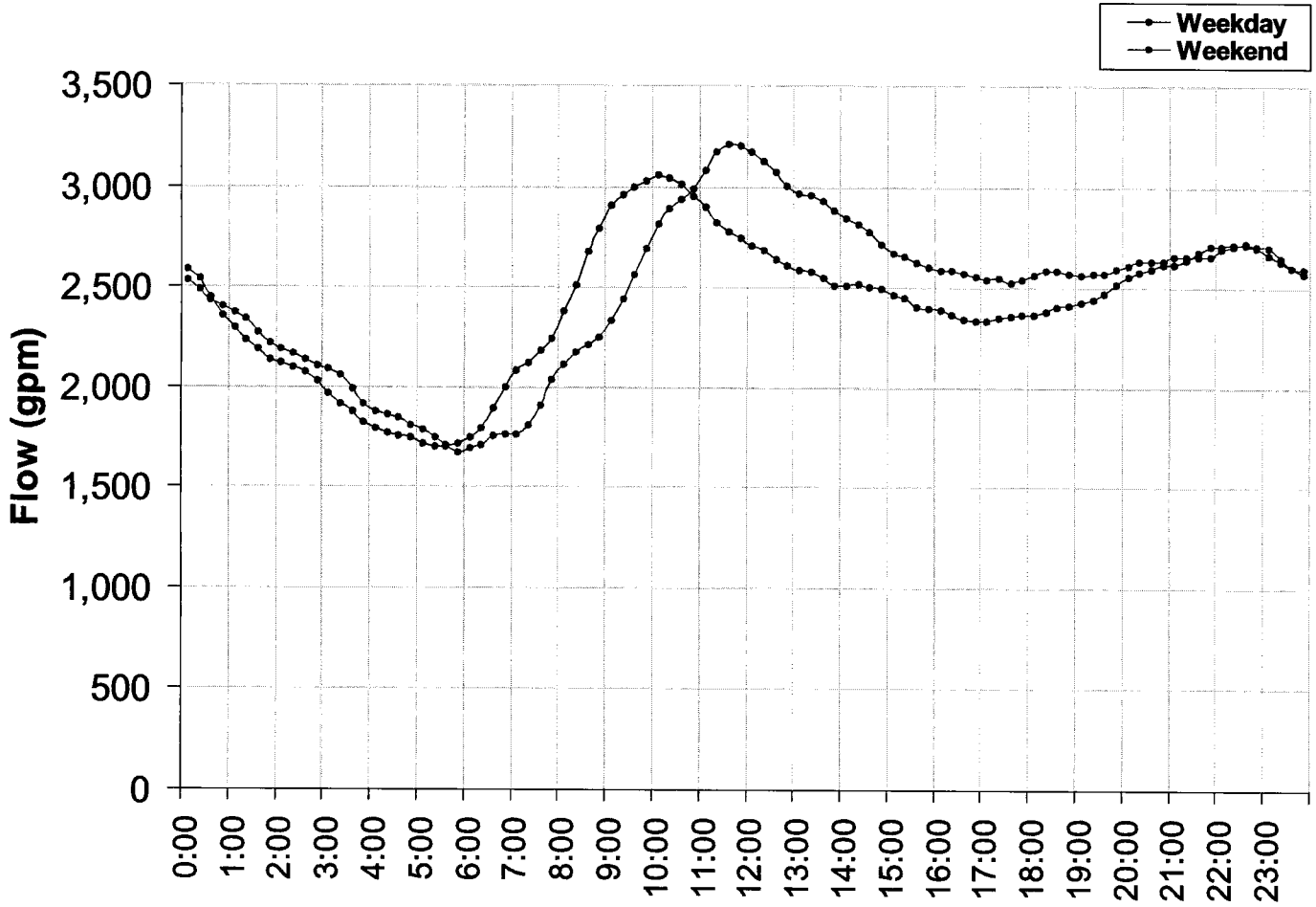
Plan view photo:



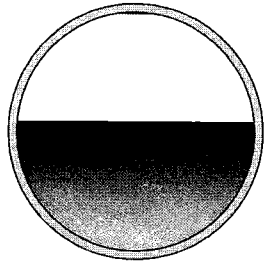
V&A

Average Dry Weather Flow

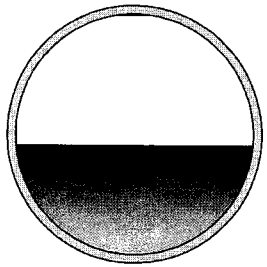
Monitoring Site:
Site 1



Peak Measured Flow:
3,407 *gpm*



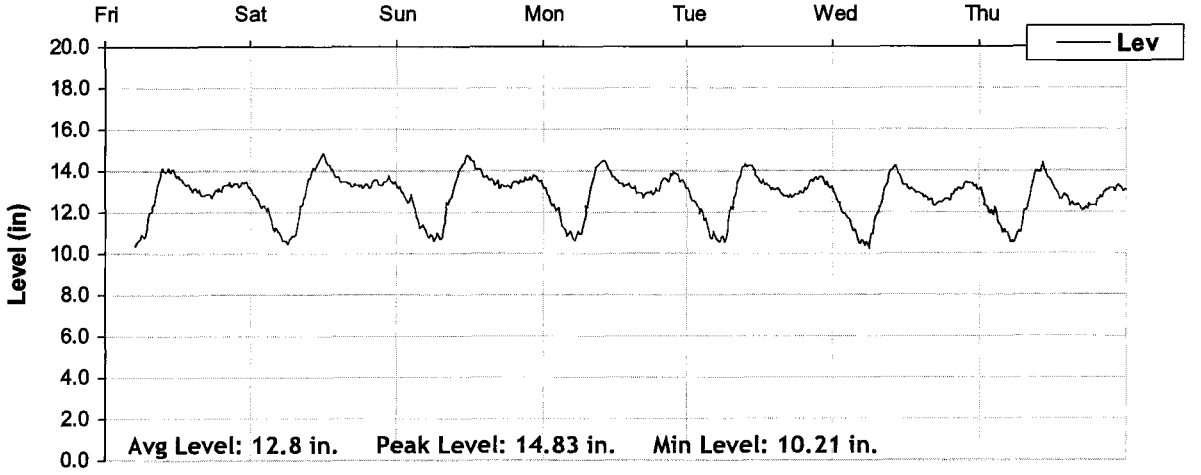
Average Dry Weather Flow:
2,426 *gpm*

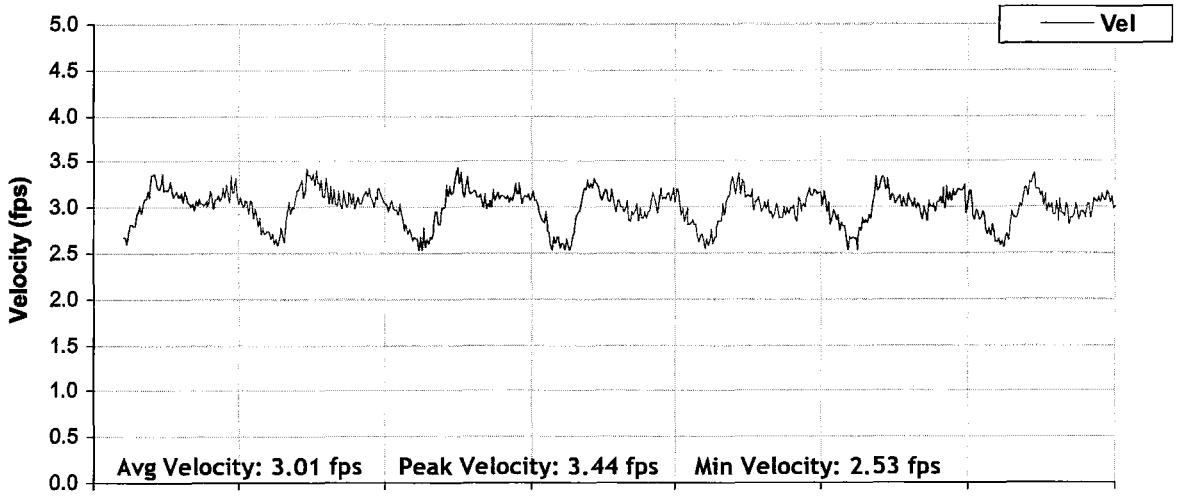


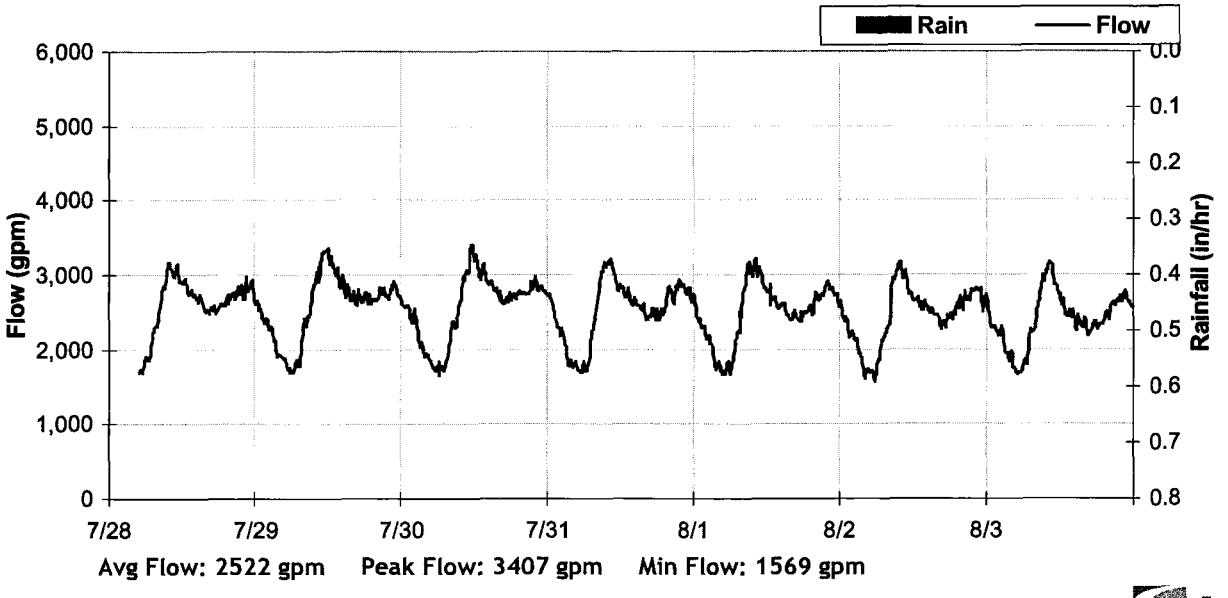
V&A

Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 1



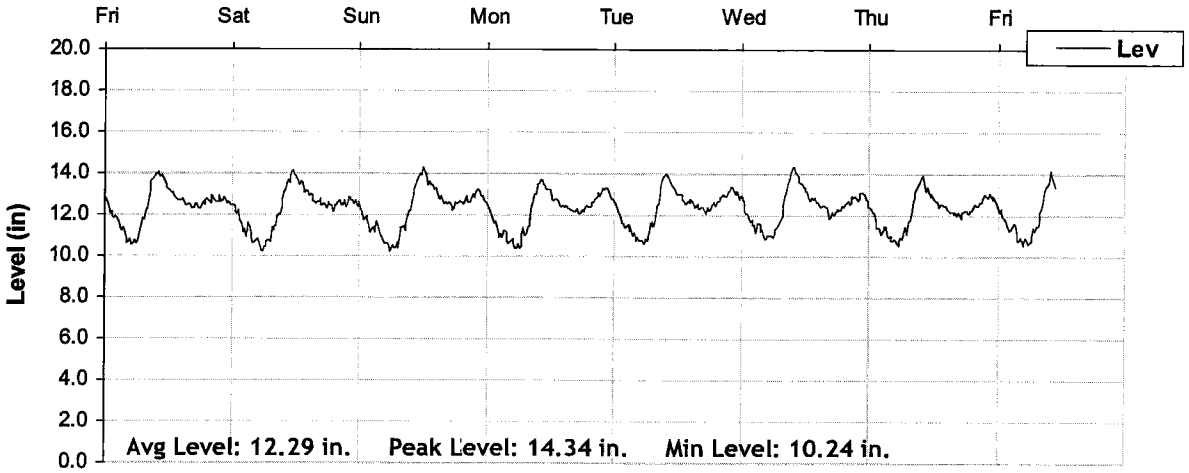


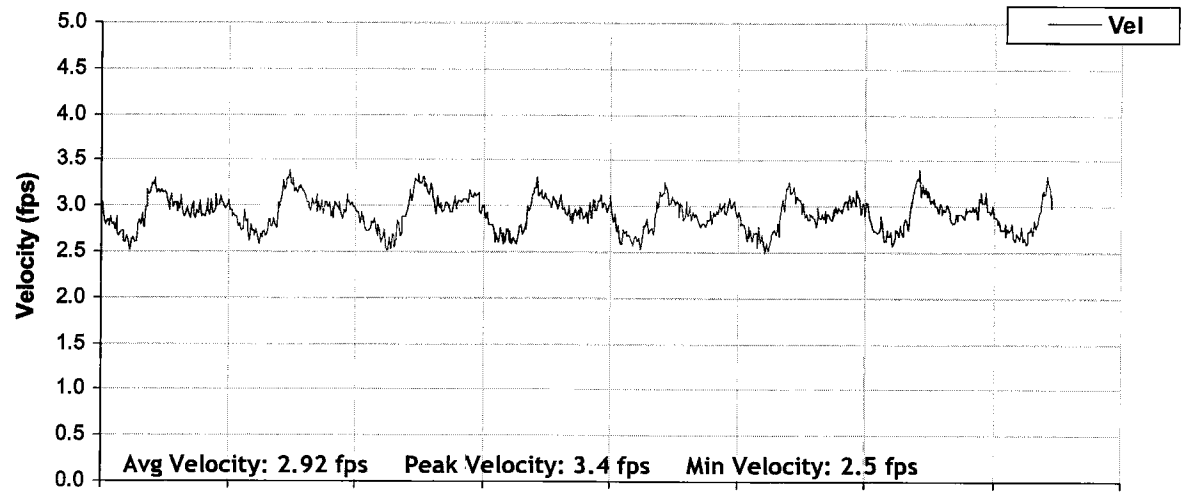


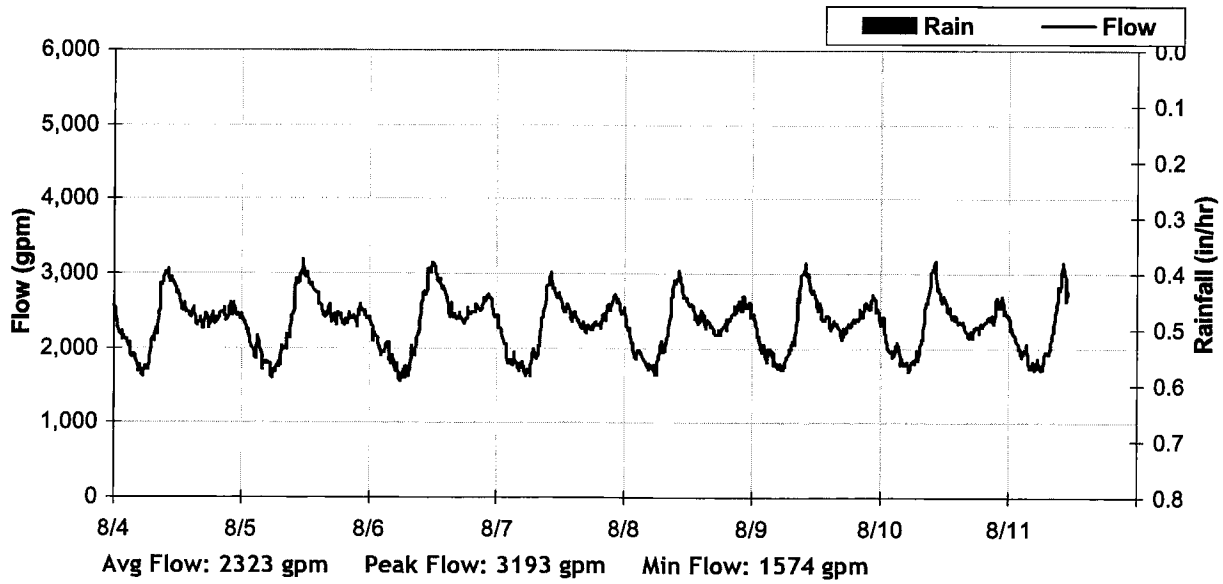
V&A

Level, Velocity and Flow
From 8/4/2006 to 8/11/2006

Monitoring Site:
Site 1







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Site Information Report

Monitoring Site: Site 2

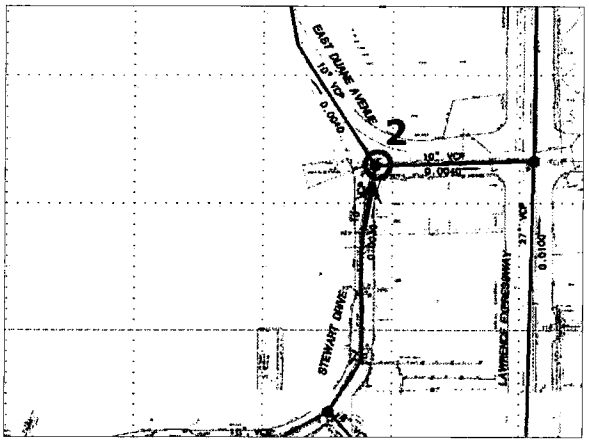
Location: In intersection of Stewart Drive and East Duane Avenue
Traffic: Busy intersection with frequent congestion

Diameter: 10 inches
Pipe material: VCP

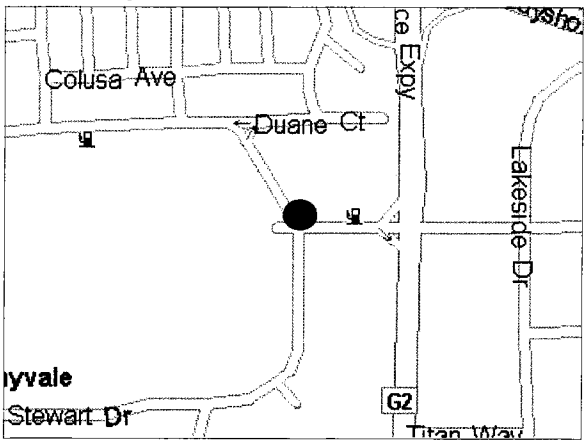
Average Dry Weather Flow: 83 *gpm*
Peak Measured Flow: 215 *gpm*

Sites upstream from this site: None

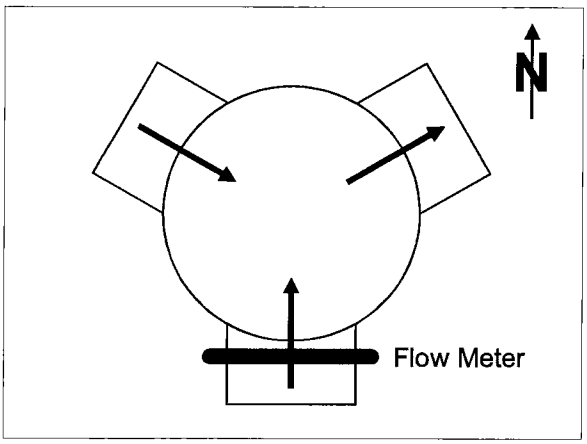
Sanitary sewer map:



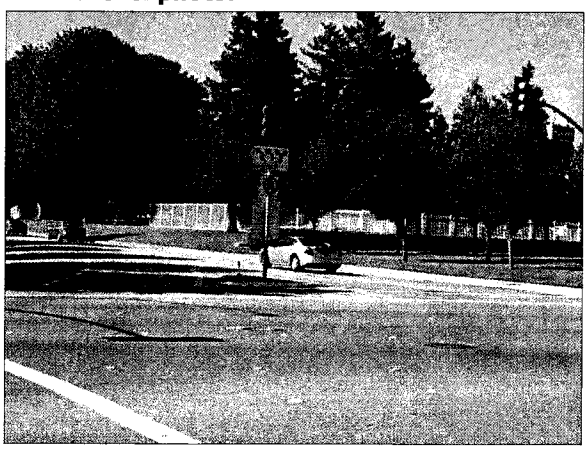
Street map:



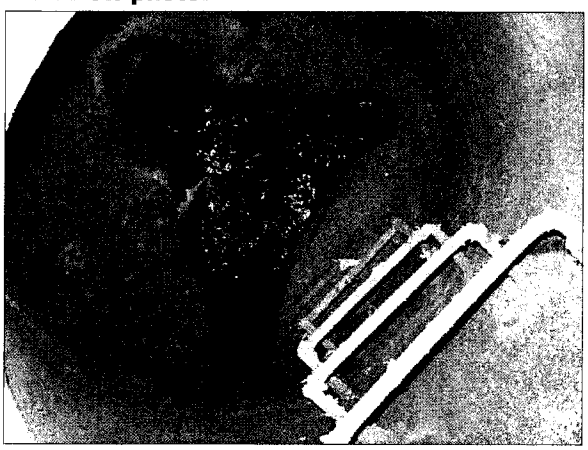
Flow sketch:



Street-level photo:



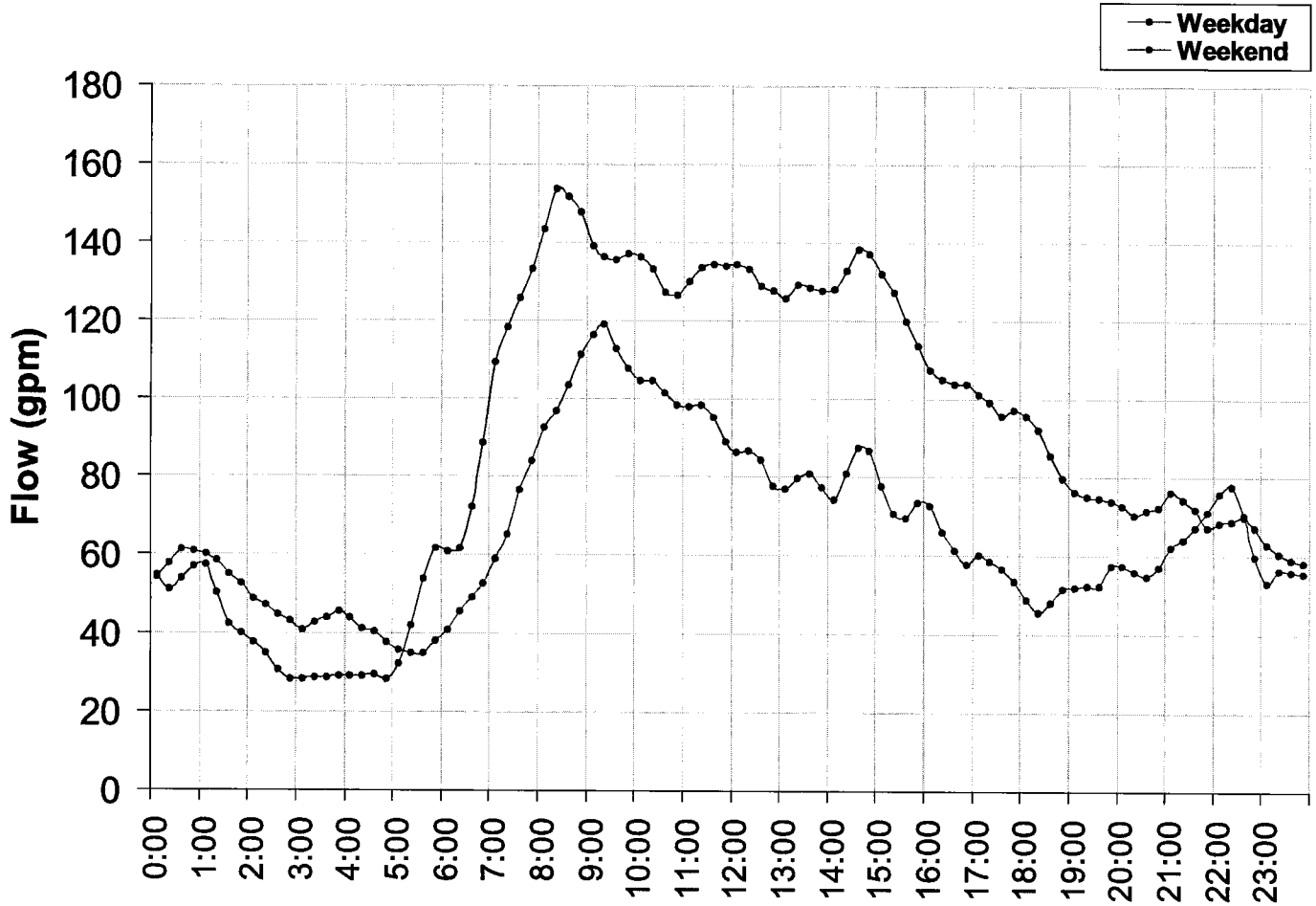
Plan view photo:



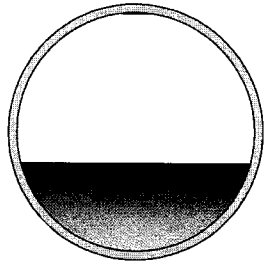
V&A

Average Dry Weather Flow

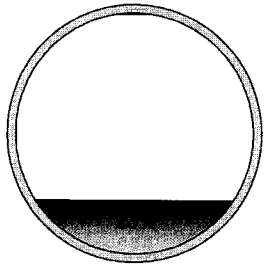
Monitoring Site:
Site 2



Peak Measured Flow:
215 *gpm*



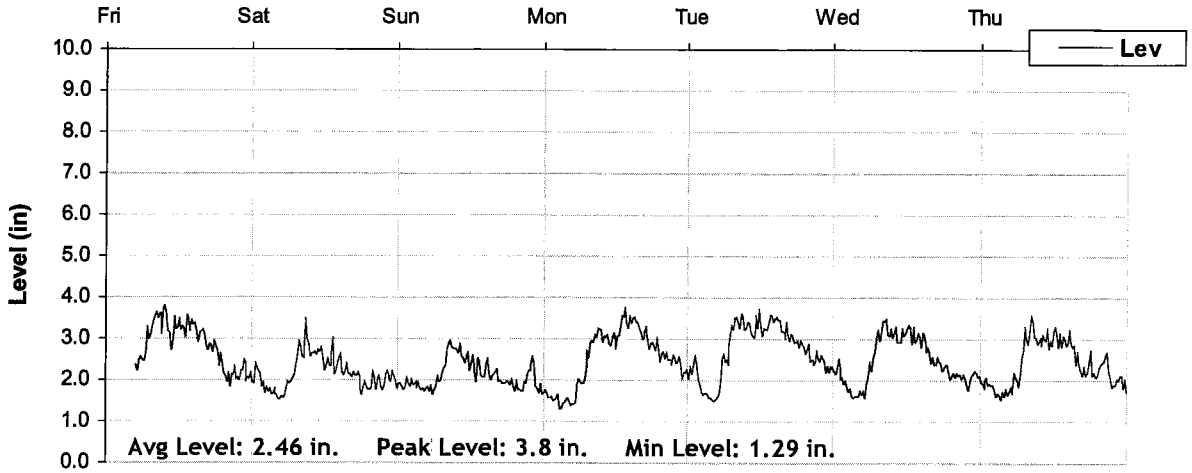
Average Dry Weather Flow:
83 *gpm*

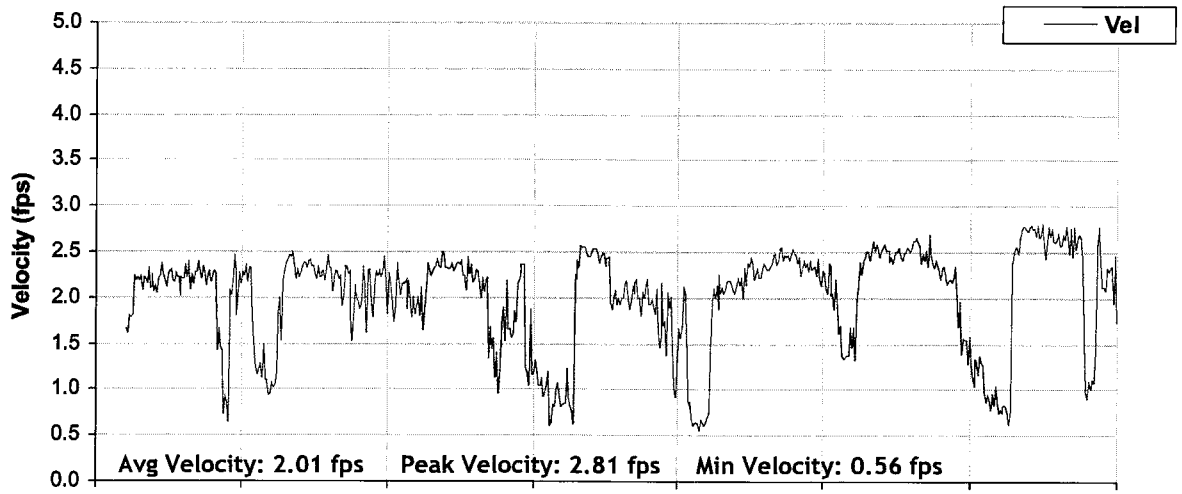


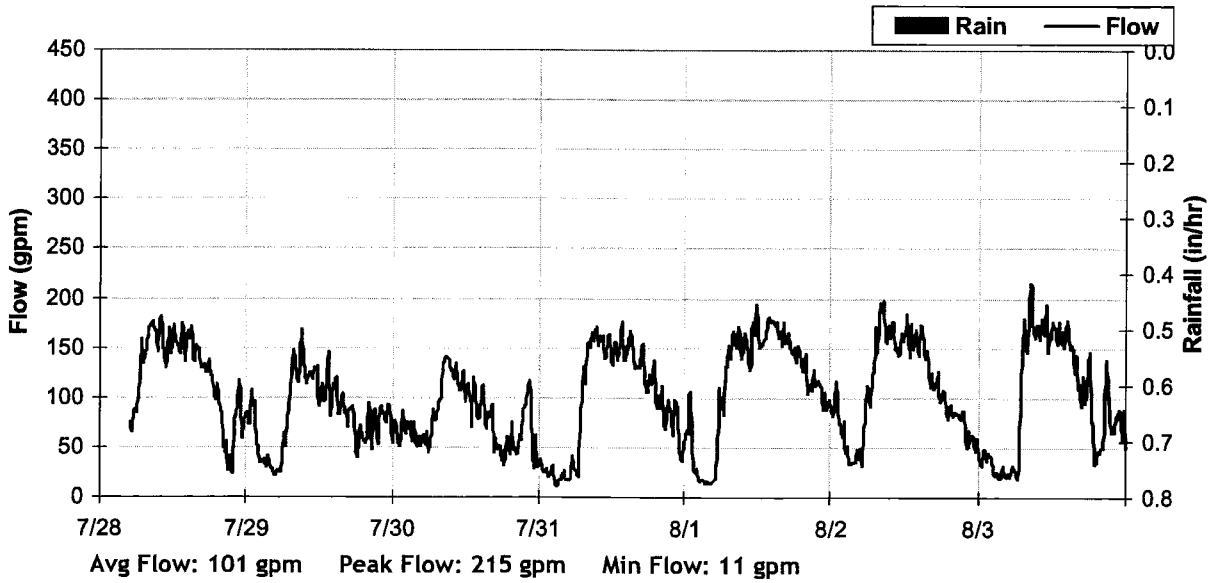
V&A

Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 2



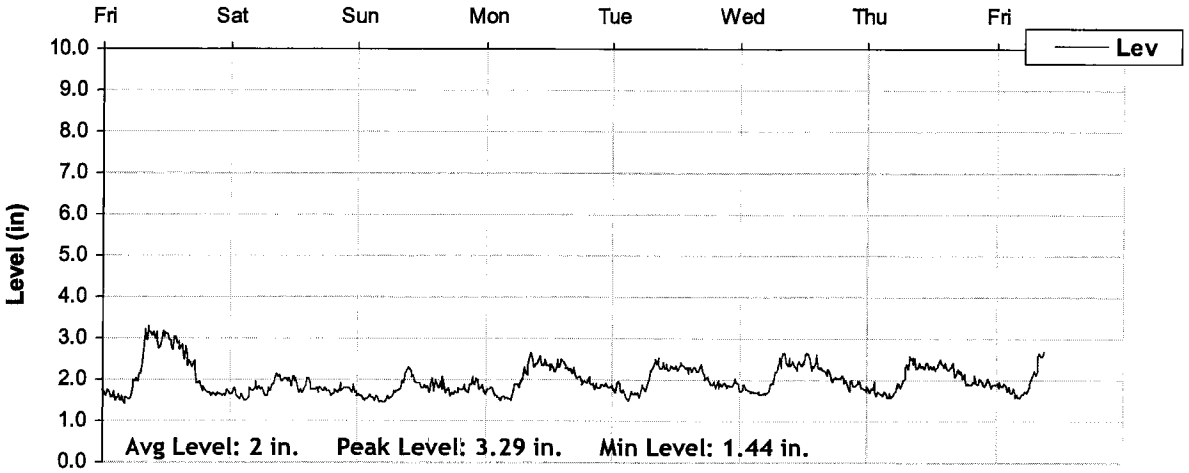


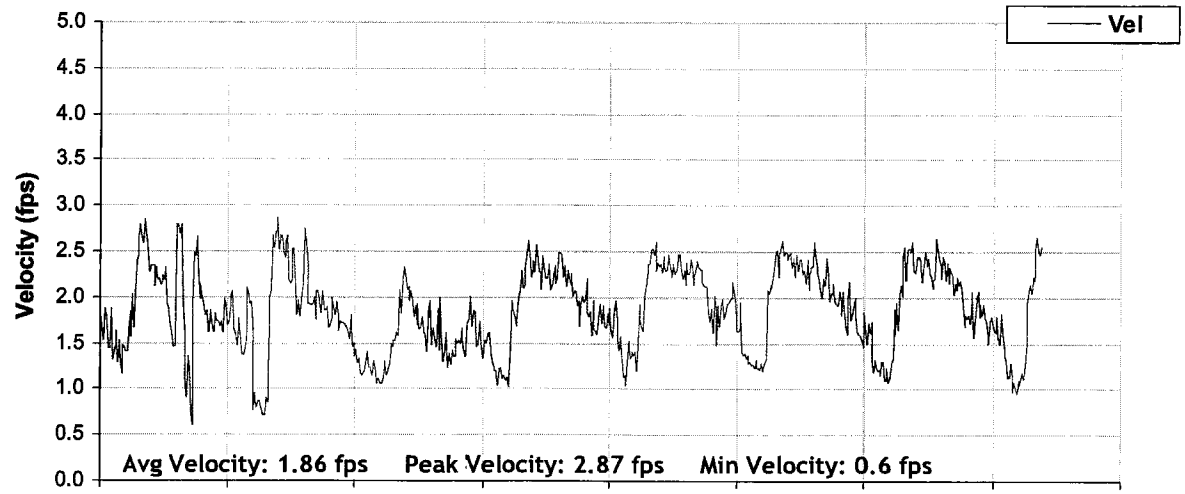


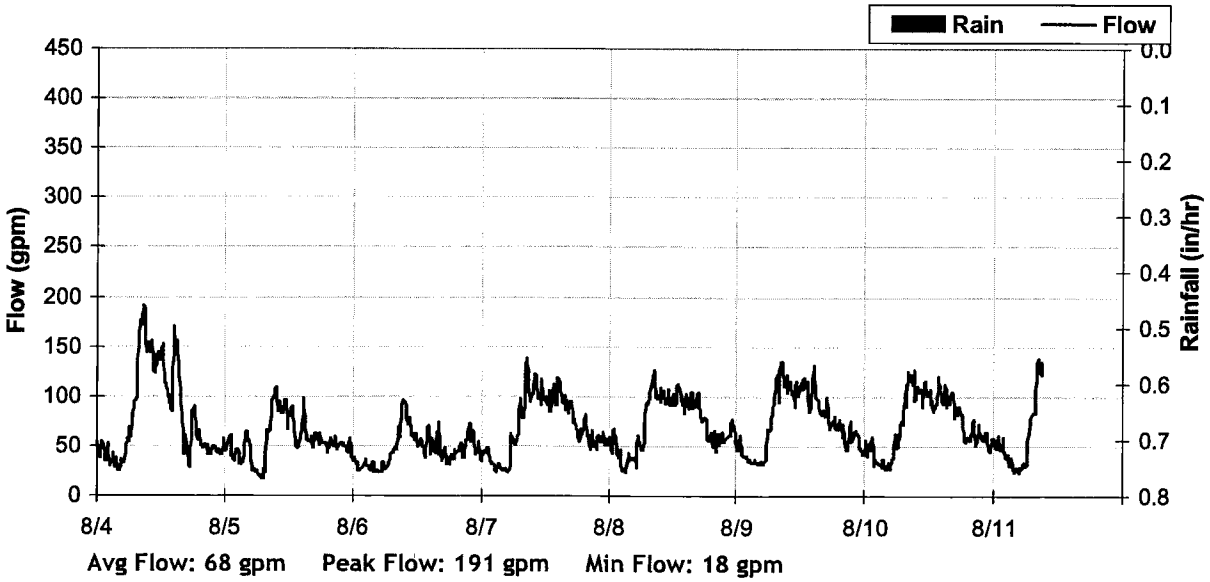
V&A

Level, Velocity and Flow
From 8/4/2006 to 8/11/2006

Monitoring Site:
Site 2







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Site Information Report

Monitoring Site: Site 3

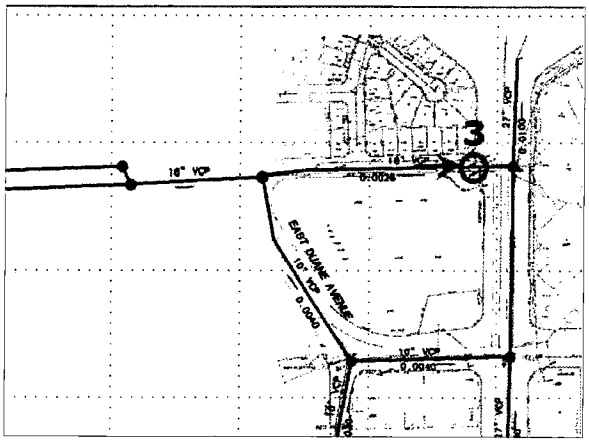
Location: End of Duane Avenue at Lawrence Expressway
Traffic: Dead end of street with very little traffic

Diameter: 18 inches
Pipe material: VCP

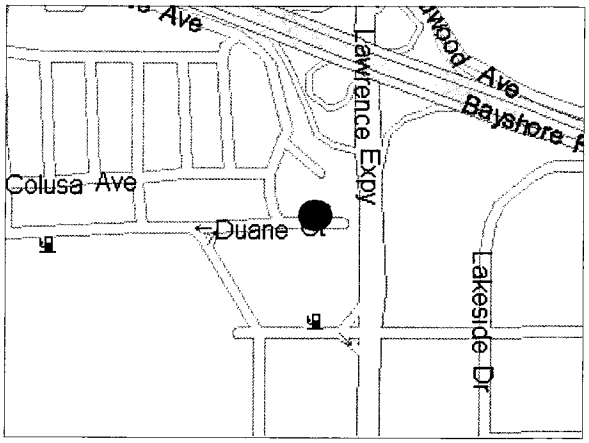
Average Dry Weather Flow: 586 *gpm*
Peak Measured Flow: 730 *gpm*

Sites upstream from this site: Sites 4, 5, 6, 7 and 8

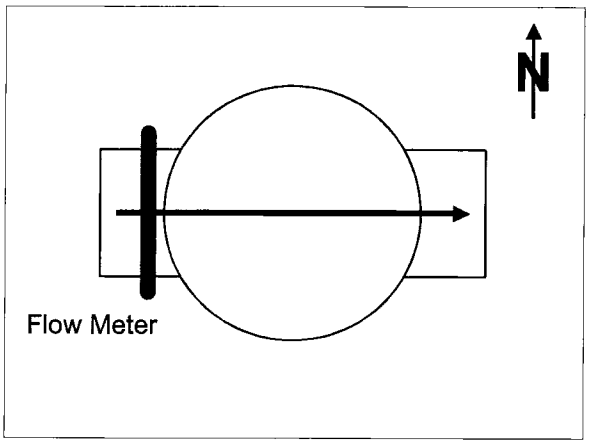
Sanitary sewer map:



Street map:

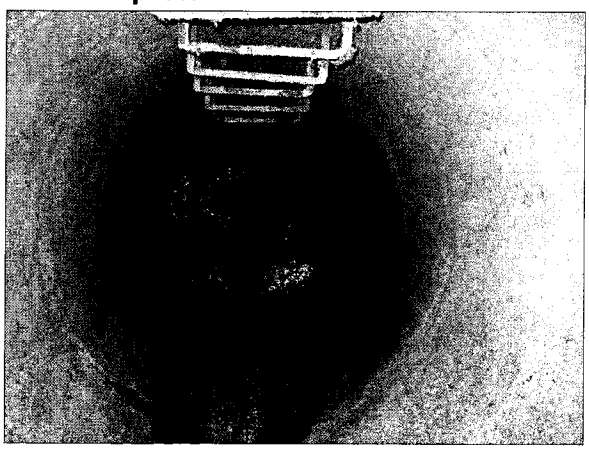


Flow sketch:



Street-level photo:

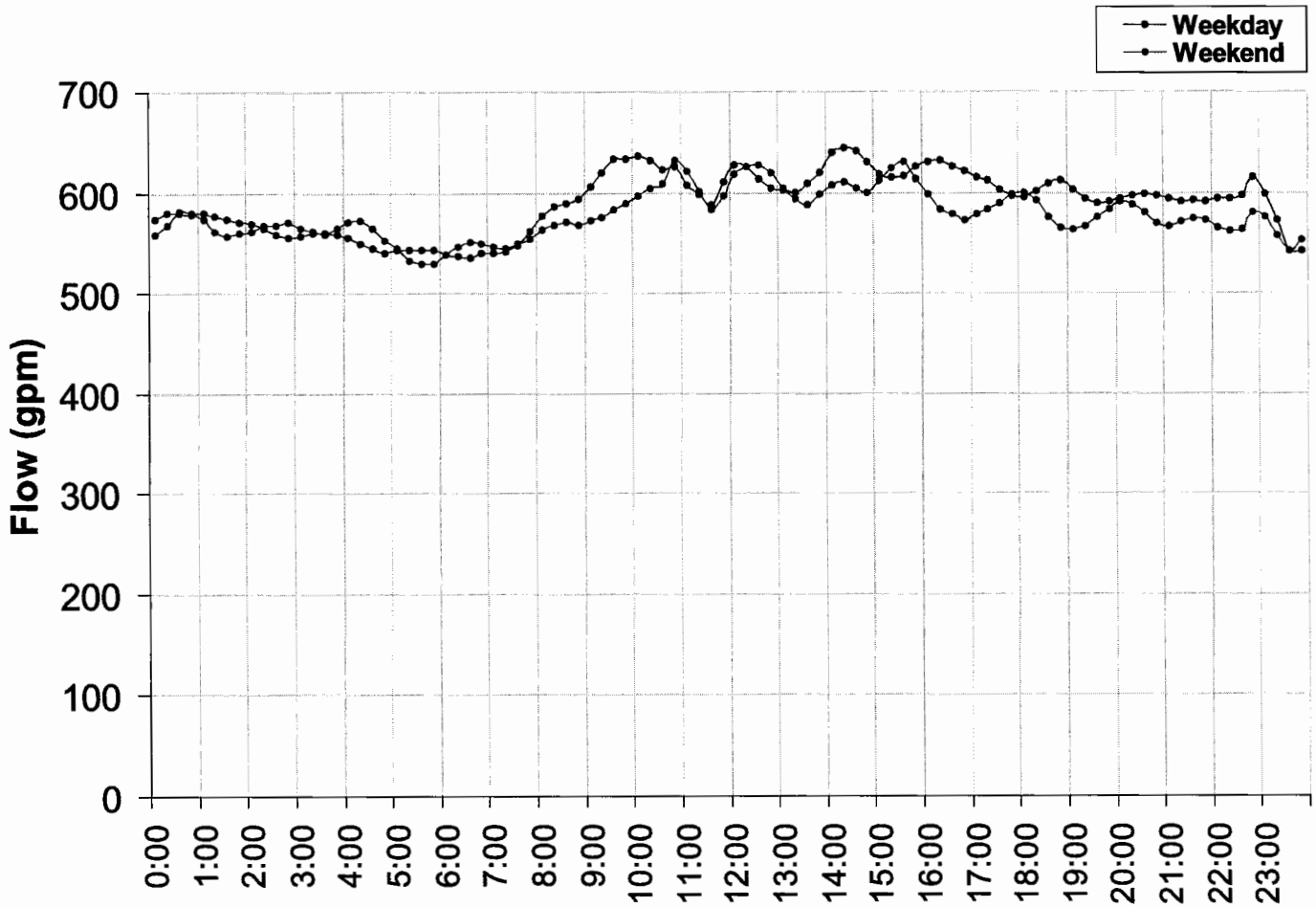
Plan view photo:



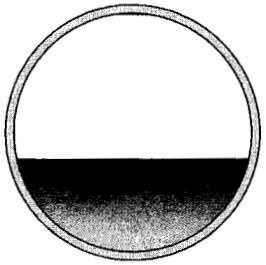
V&A

Average Dry Weather Flow

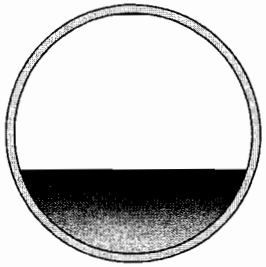
Monitoring Site:
Site 3



Peak Measured Flow:
730 *gpm*



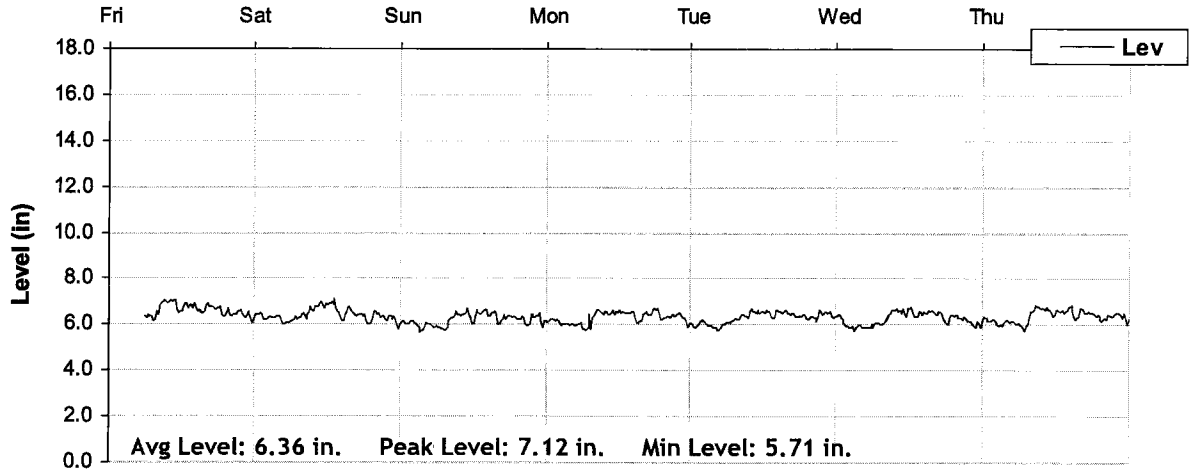
Average Dry Weather Flow:
586 *gpm*

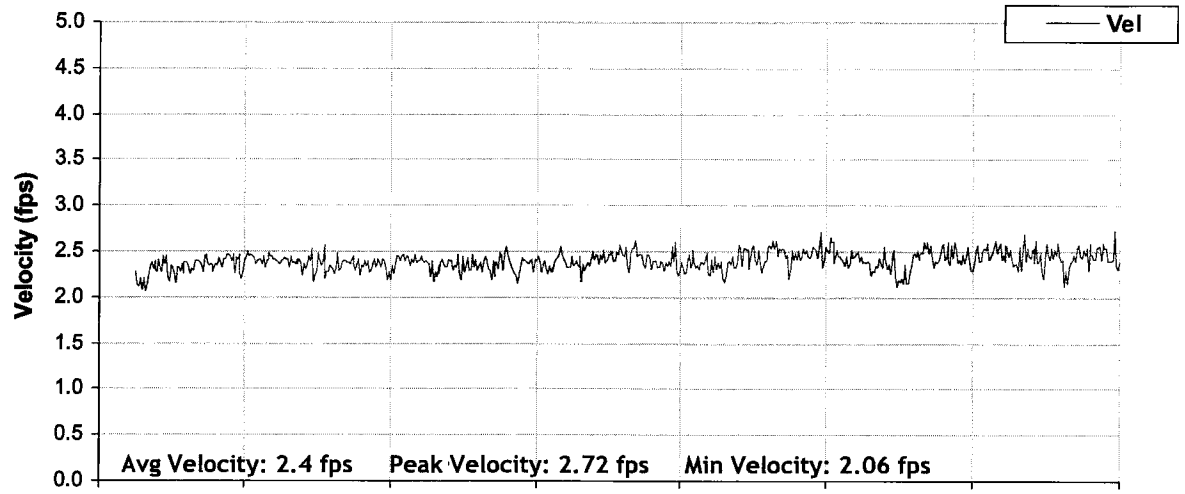


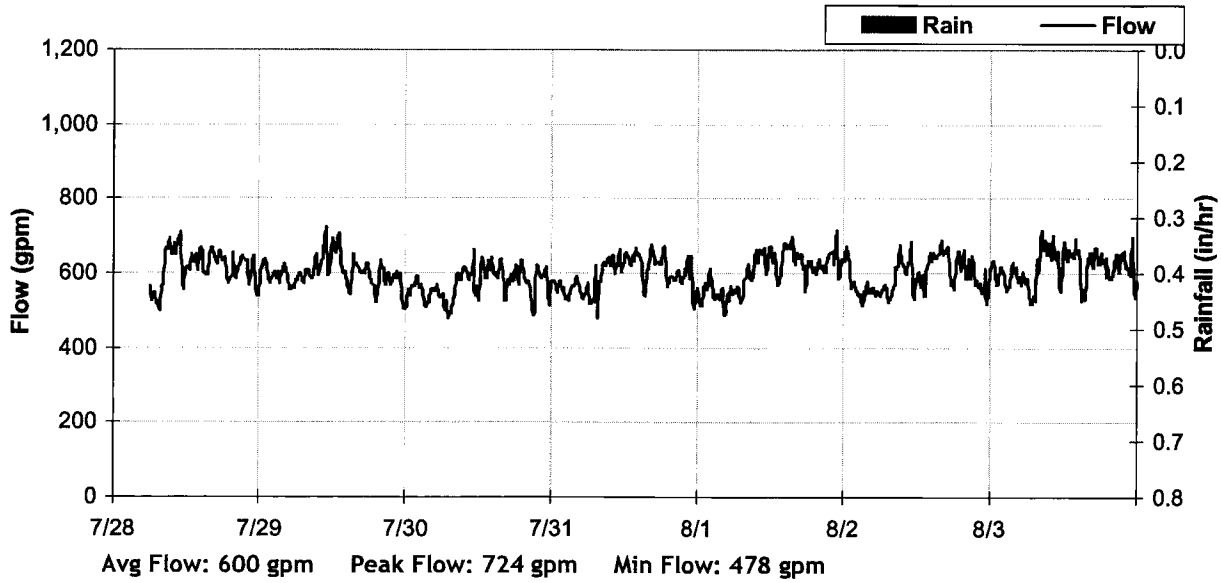
V&A

Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 3



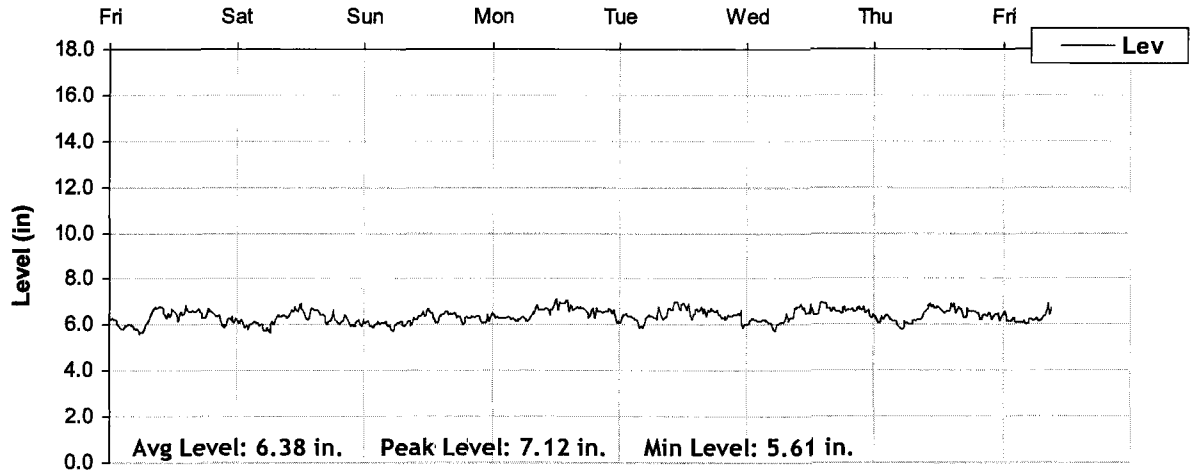


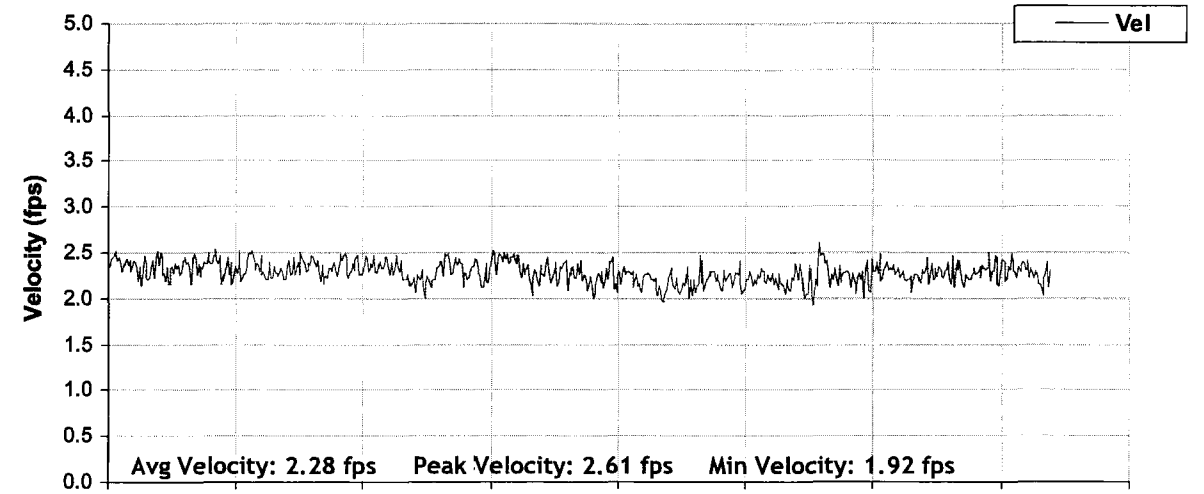


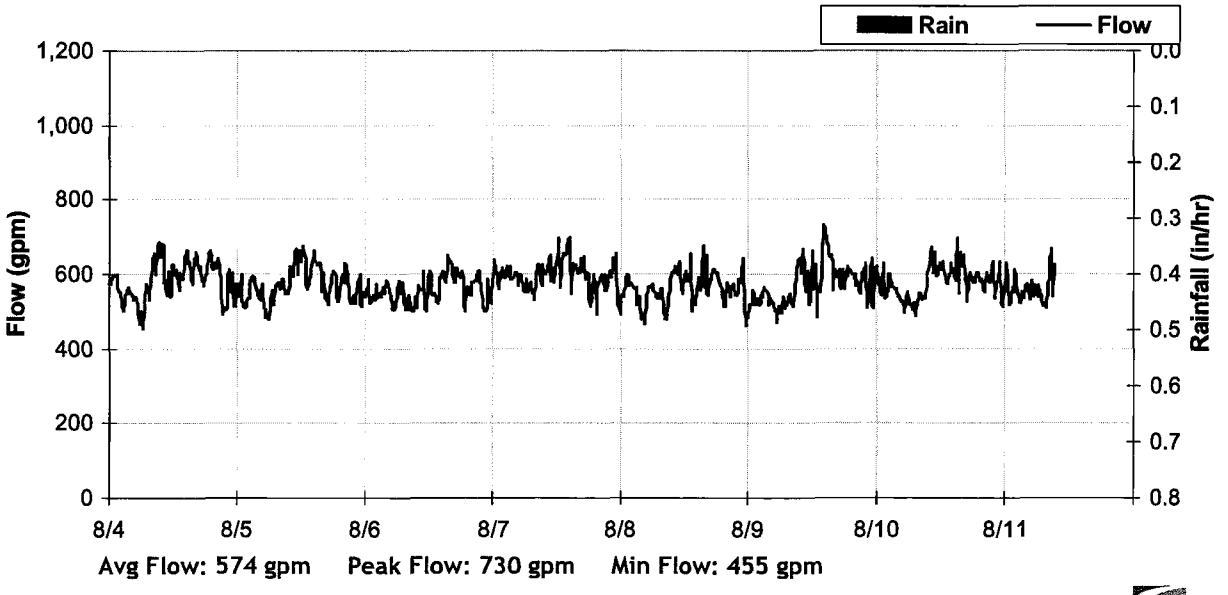
V&A

Level, Velocity and Flow
From 8/4/2006 to 8/11/2006

Monitoring Site:
Site 3







V&A

Site Information Report

Monitoring Site: Site 4

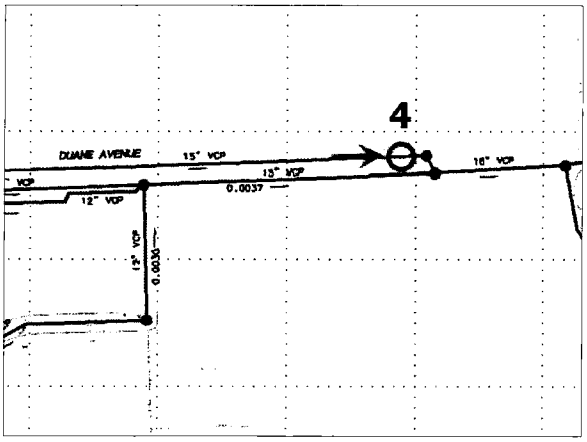
Location: Leftmost eastbound lane of Duane Avenue west of San Simeon Street
Traffic: Moderate

Diameter: 15 inches
Pipe material: VCP

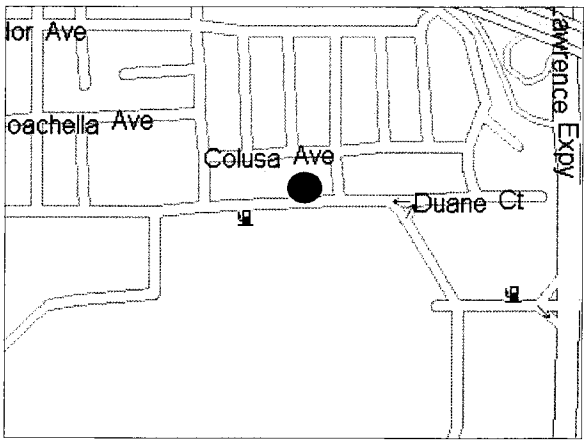
Average Dry Weather Flow: 27 *gpm*
Peak Measured Flow: 90 *gpm*

Sites upstream from this site: None

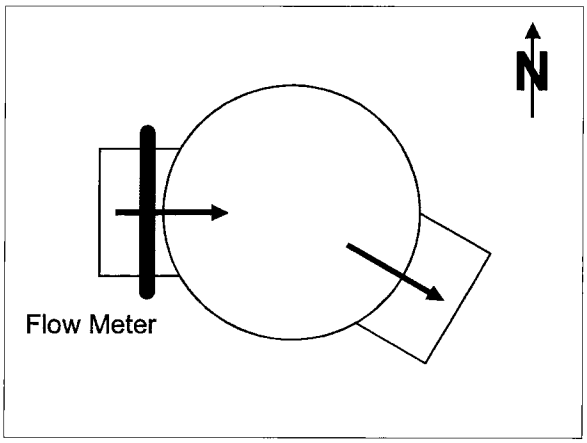
Sanitary sewer map:



Street map:

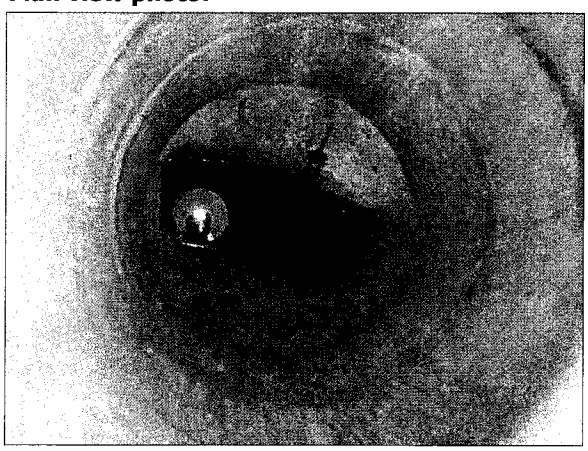


Flow sketch:



Street-level photo:

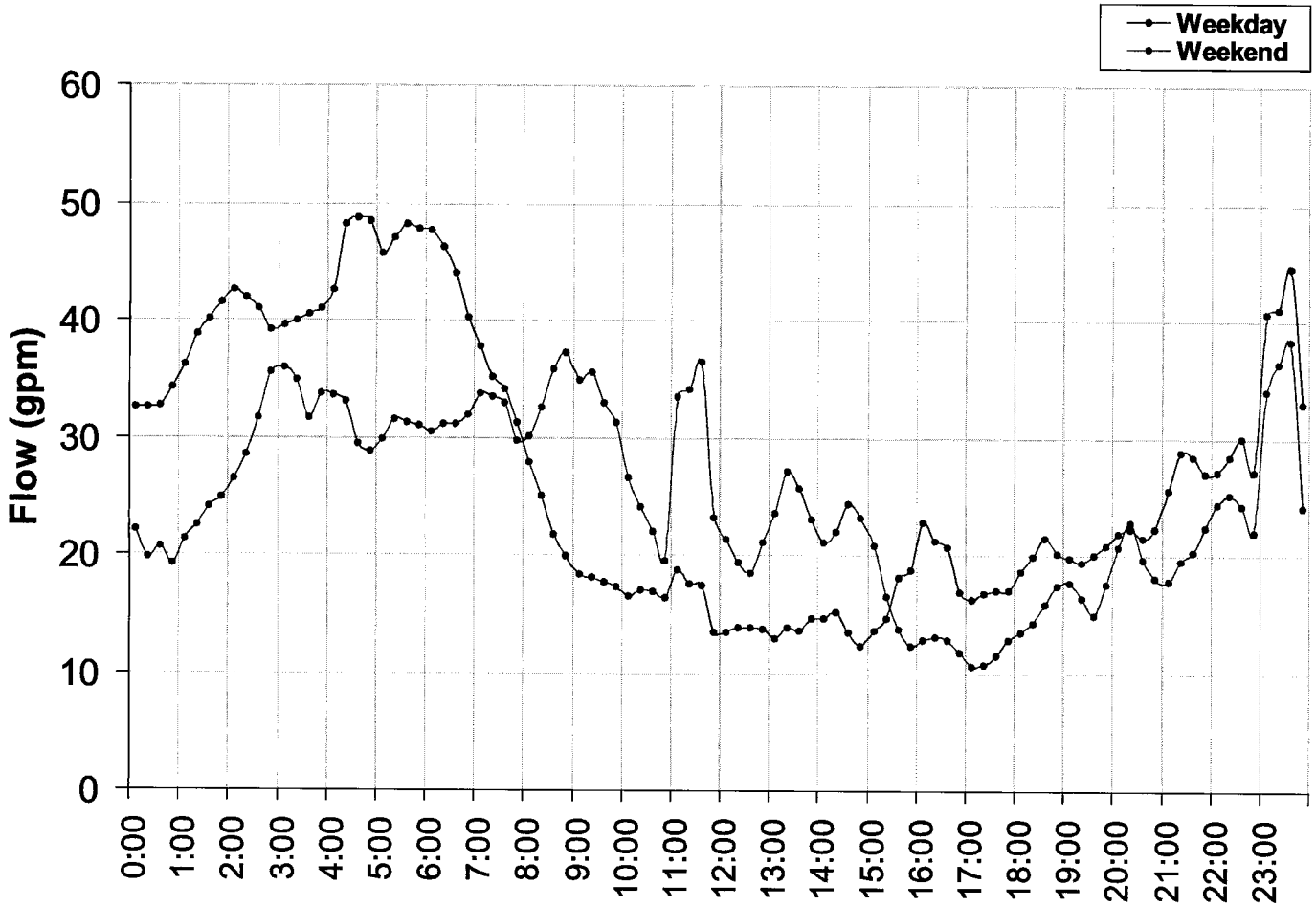
Plan view photo:



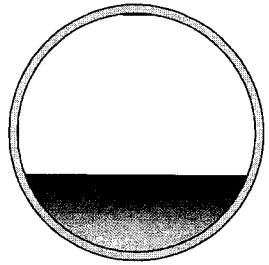
V&A

Average Dry Weather Flow

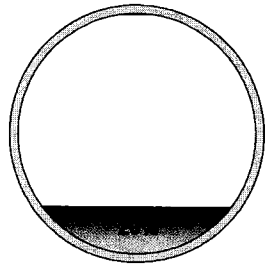
Monitoring Site:
Site 4



Peak Measured Flow:
90 *gpm*



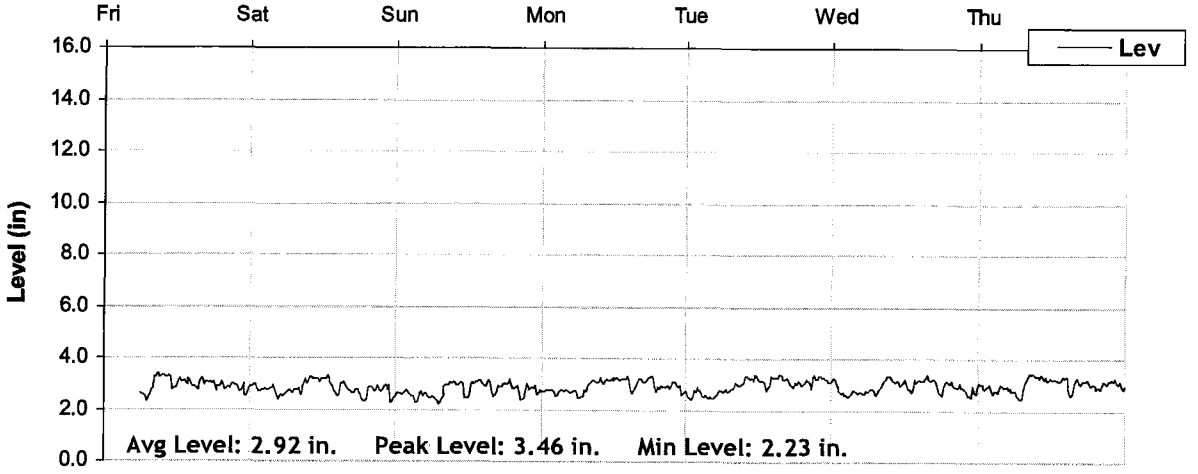
Average Dry Weather Flow:
27 *gpm*

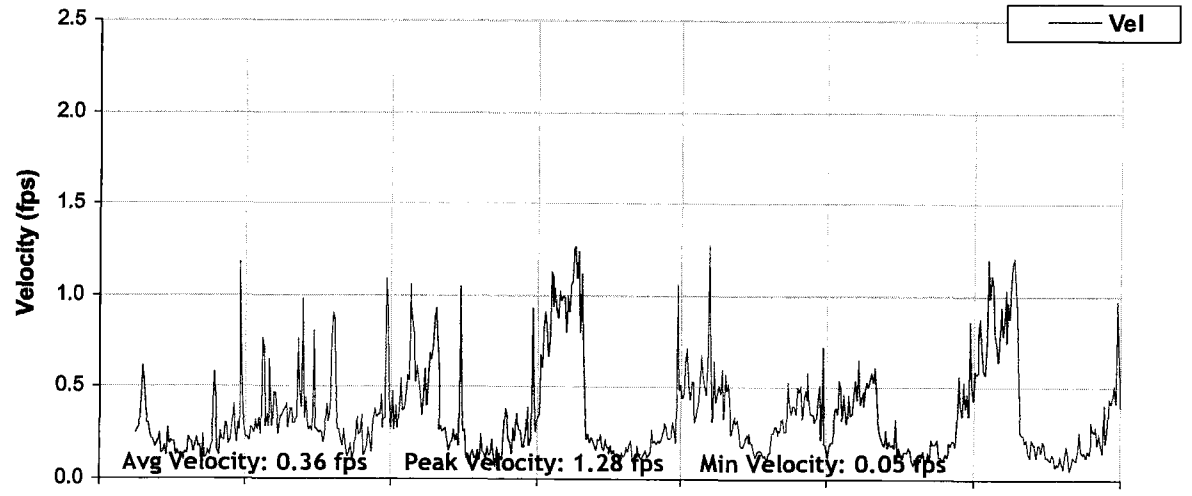


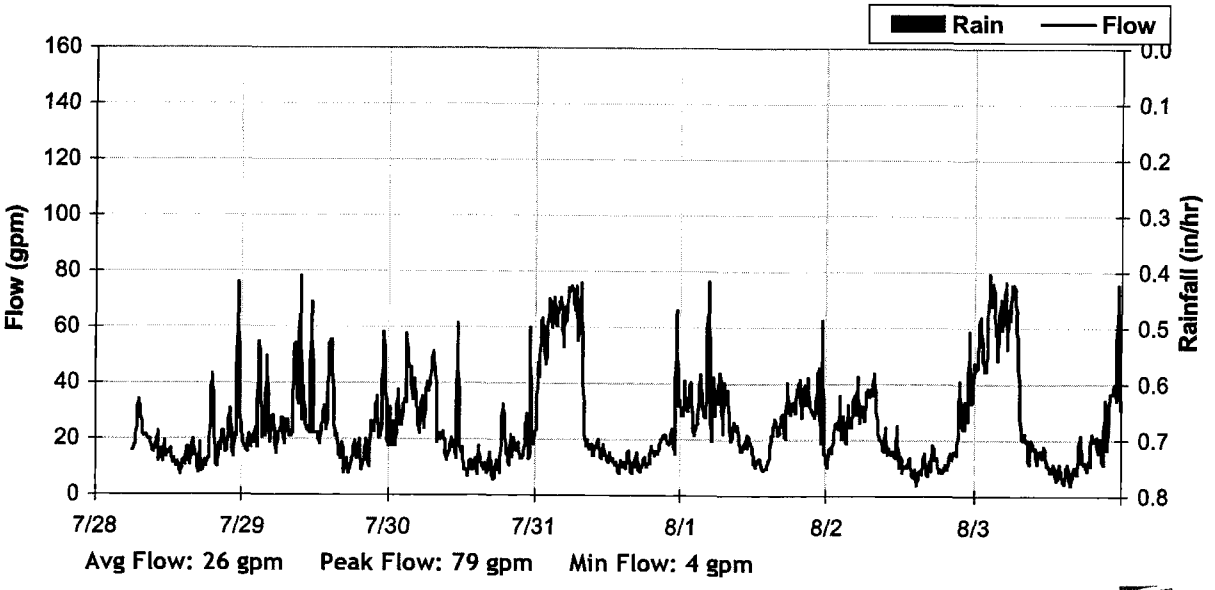
V&A

Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 4



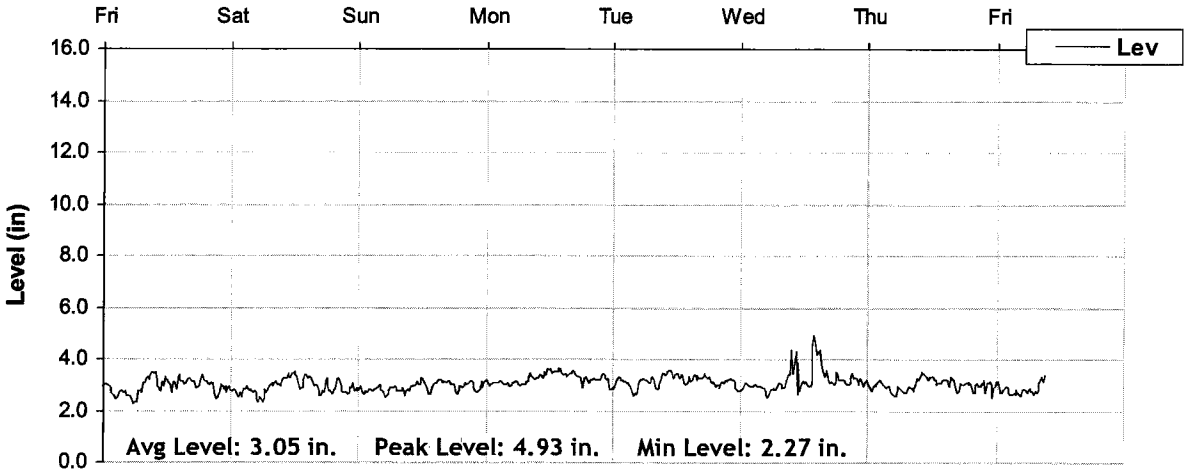


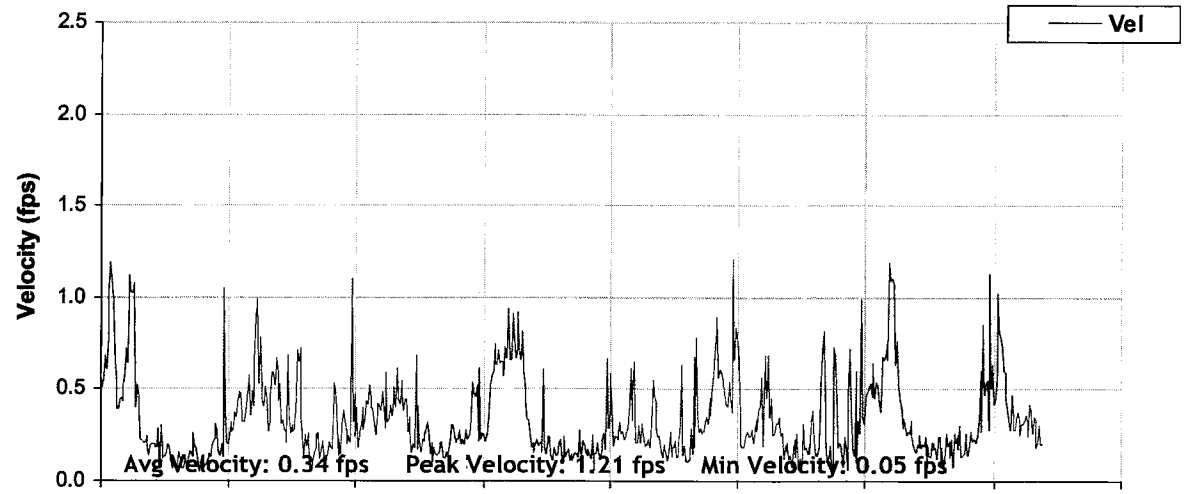


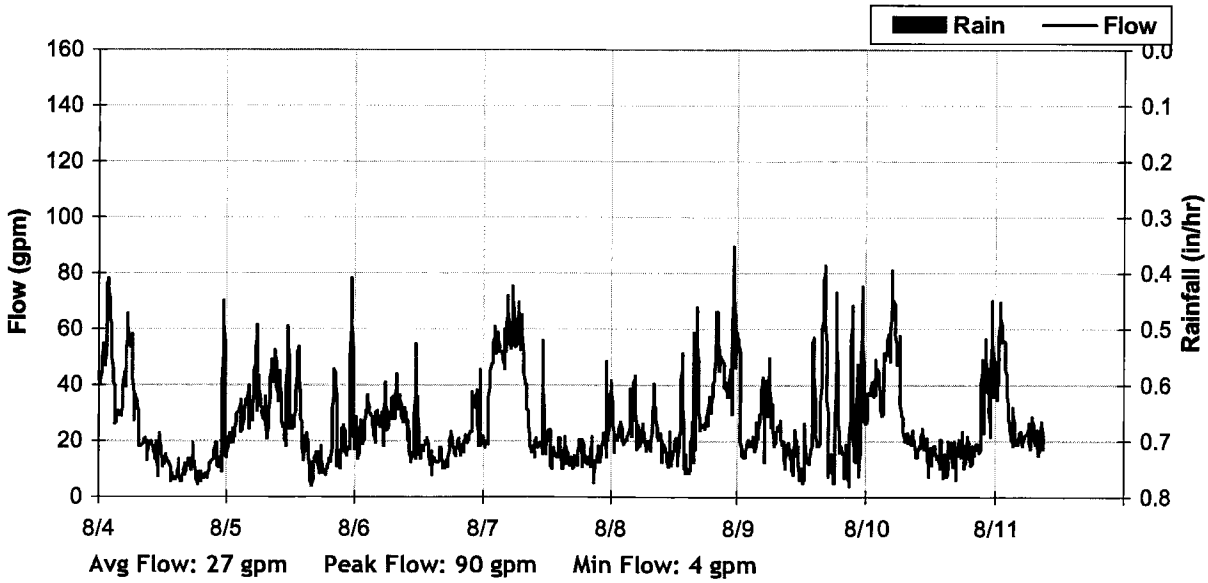
V&A

Level, Velocity and Flow
From 8/4/2006 to 8/11/2006

Monitoring Site:
Site 4







V&A

Site Information Report

Monitoring Site: Site 5

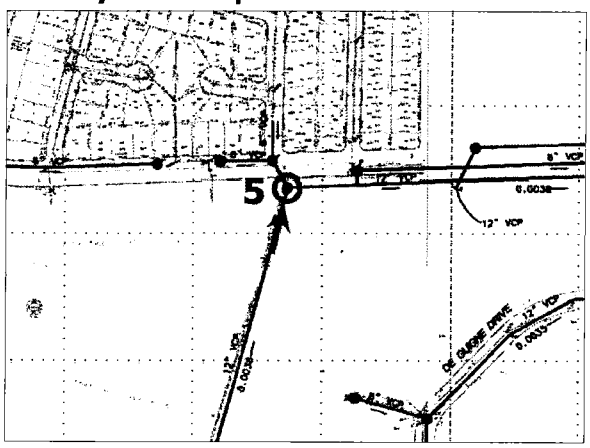
Location: Off pavement near Duane Avenue and San Luisito Way
Traffic: Moderate

Diameter: 12 inches
Pipe material: VCP

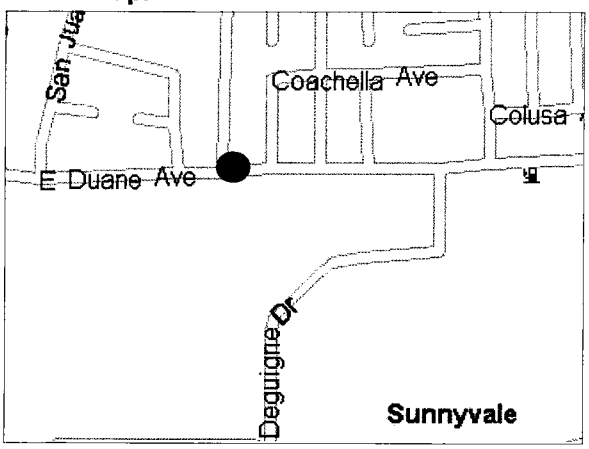
Average Dry Weather Flow: 42 *gpm*
Peak Measured Flow: 67 *gpm*

Sites upstream from this site: Site 8

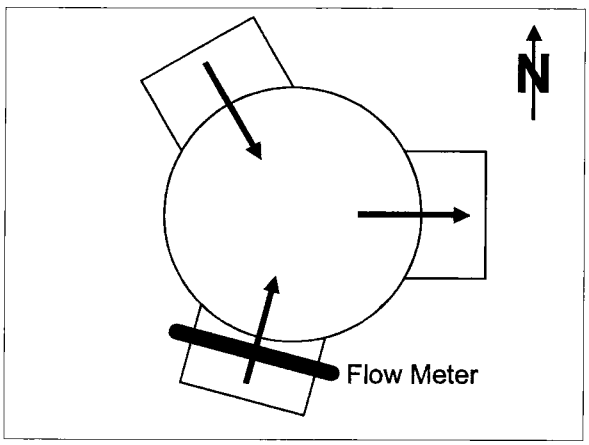
Sanitary sewer map:



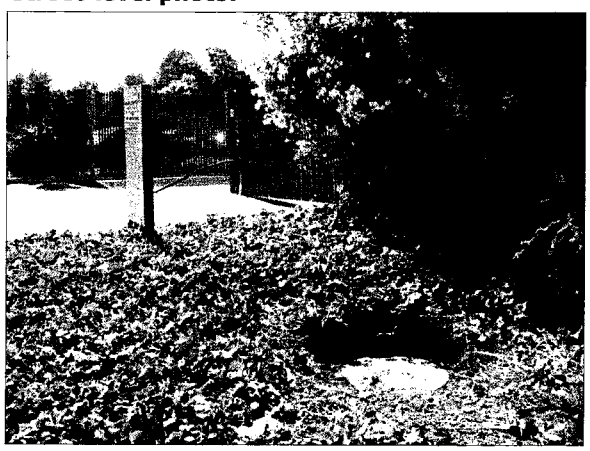
Street map:



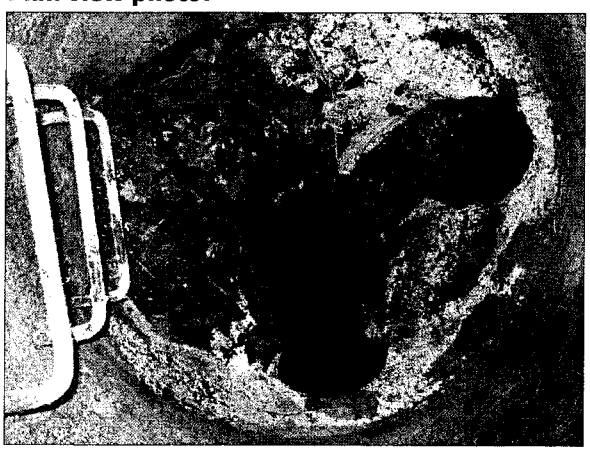
Flow sketch:



Street-level photo:



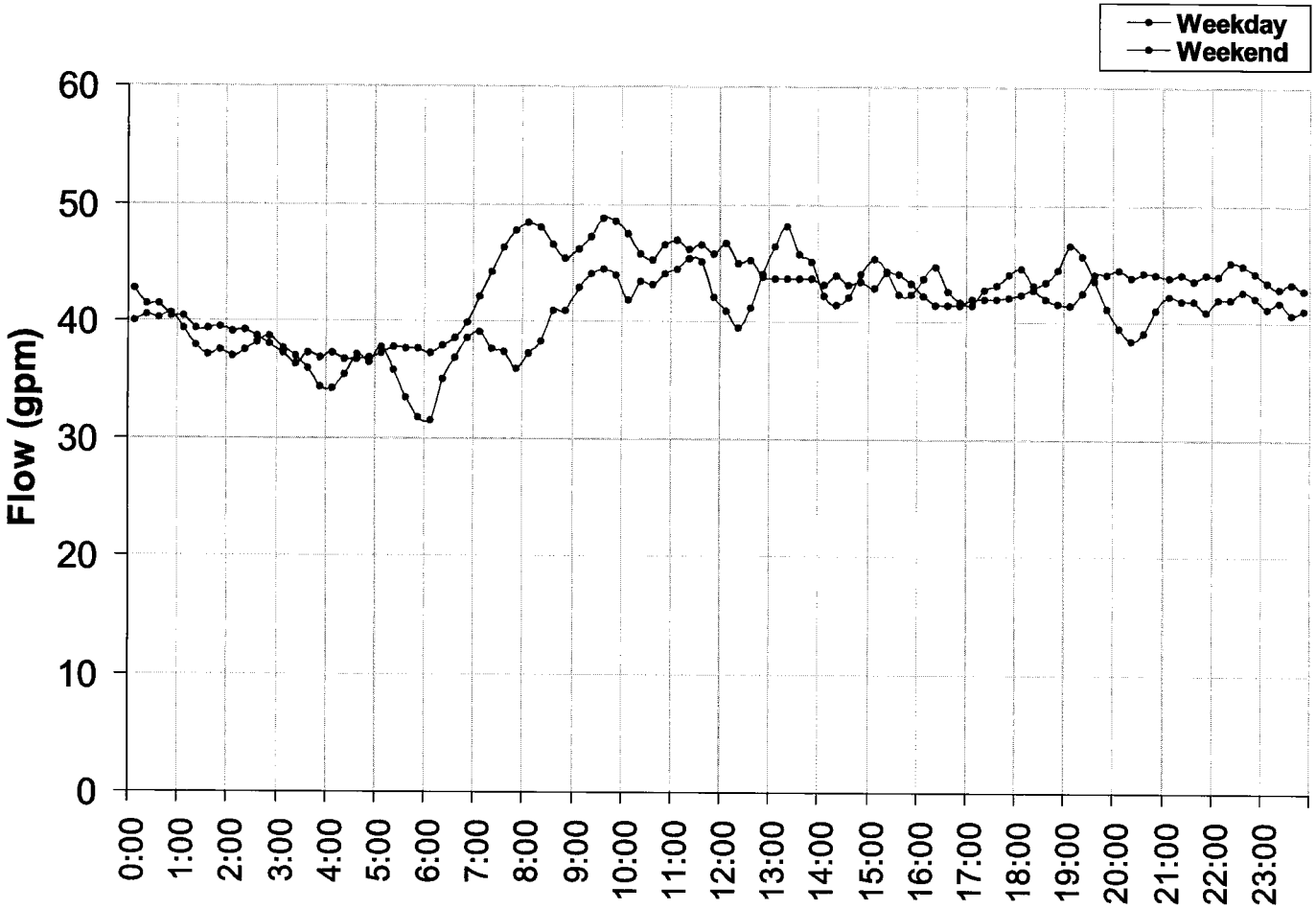
Plan view photo:



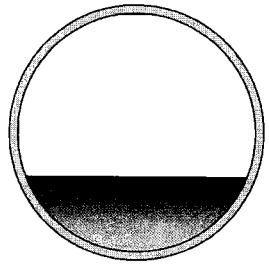
V&A

Average Dry Weather Flow

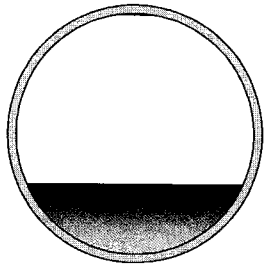
Monitoring Site:
Site 5



Peak Measured Flow:
67 *gpm*



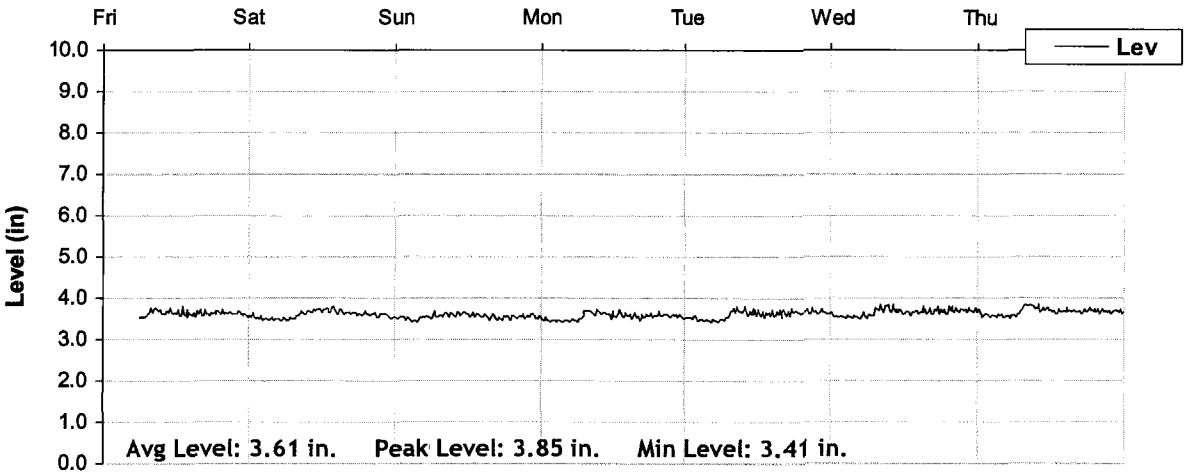
Average Dry Weather Flow:
42 *gpm*

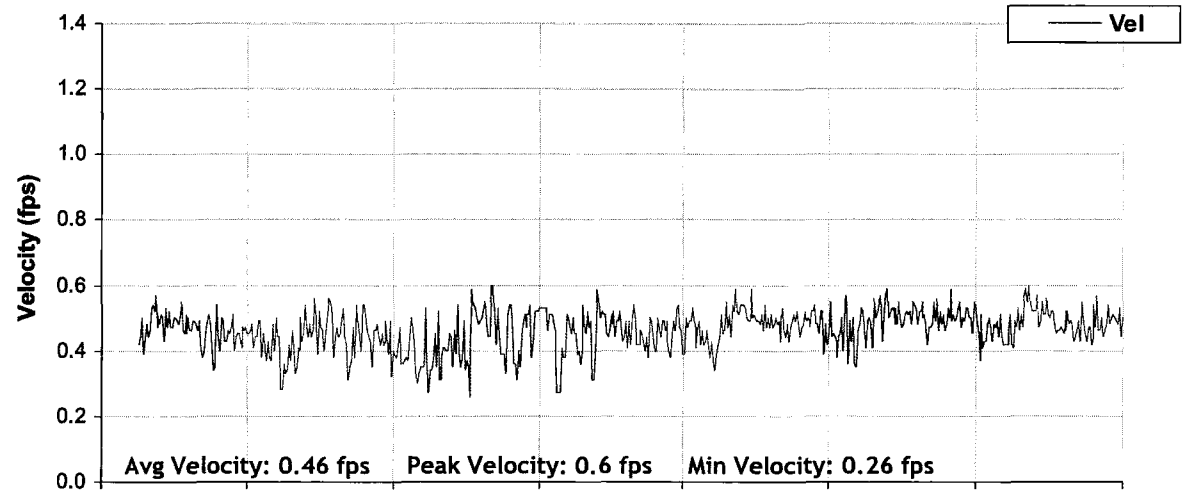


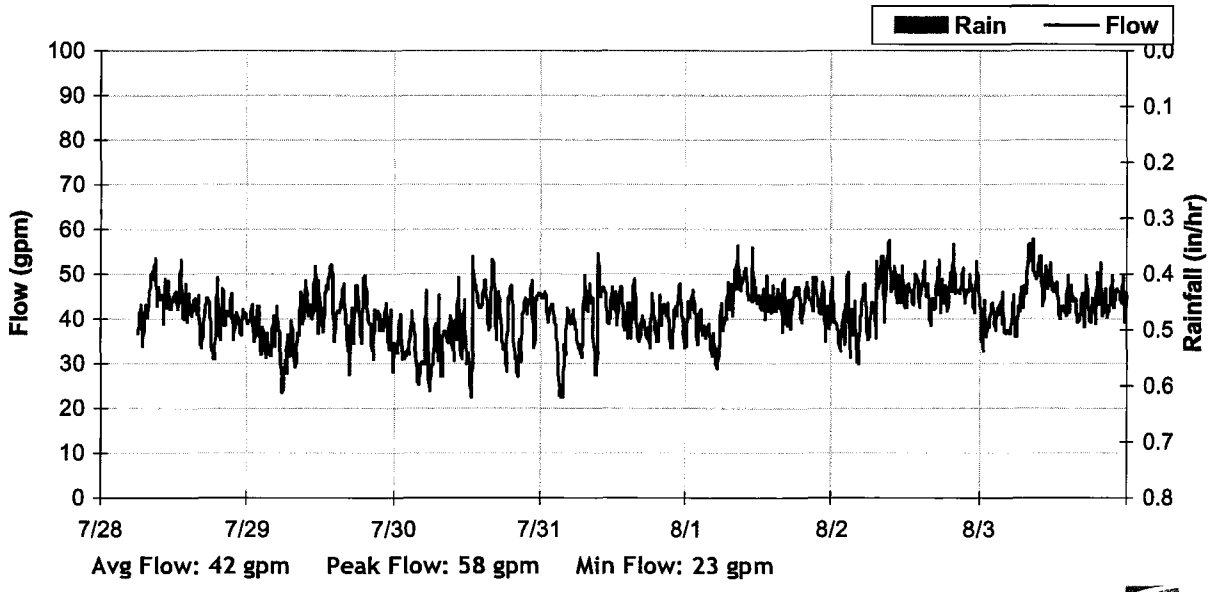
V&A

Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 5



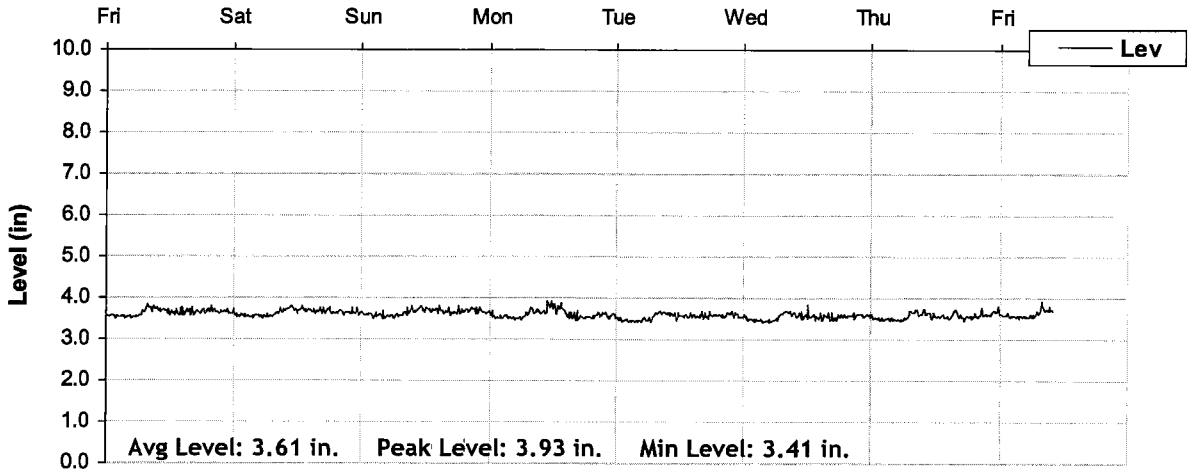


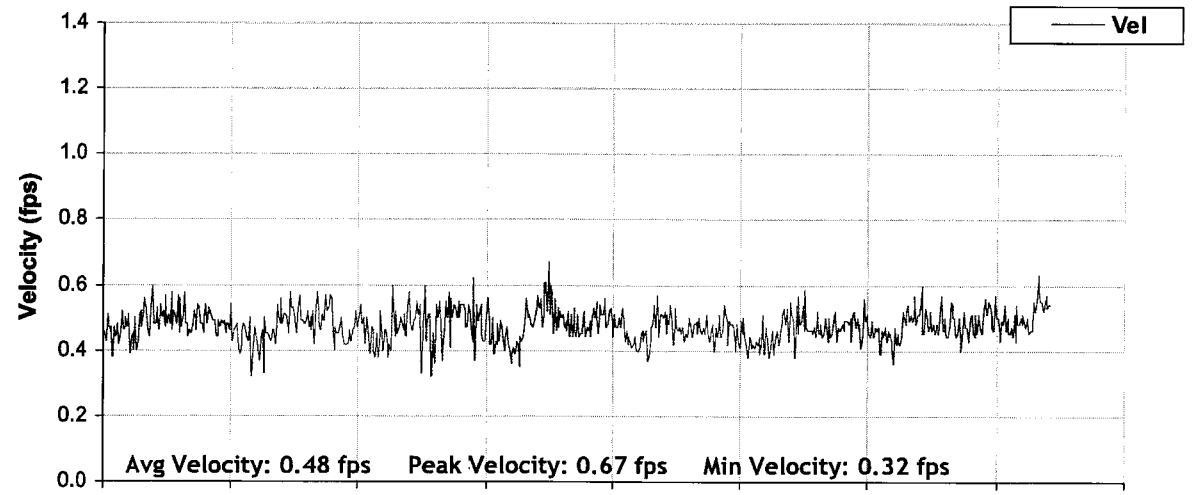


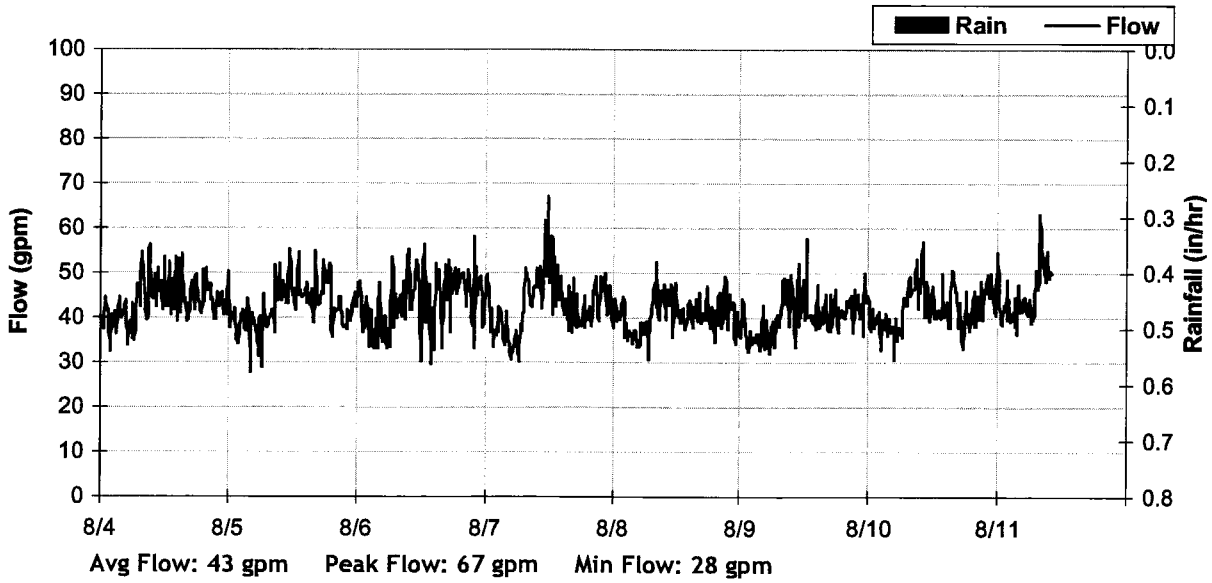
V&A

Level, Velocity and Flow
From 8/4/2006 to 8/11/2006

Monitoring Site:
Site 5







V&A

Site Information Report

Monitoring Site: Site 6

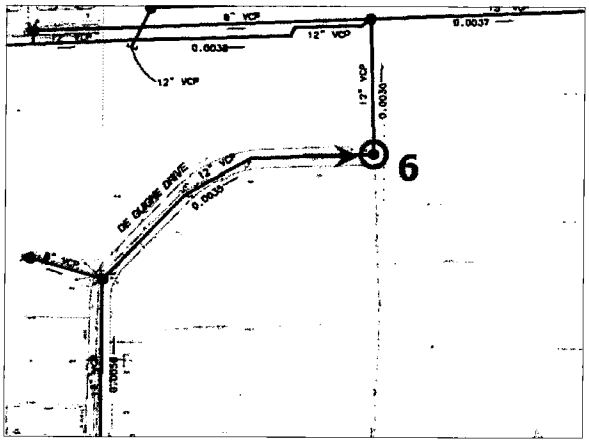
Location: Shoulder of roadway near 971 De Guigne Drive
Traffic: Little

Diameter: 12 inches
Pipe material: VCP

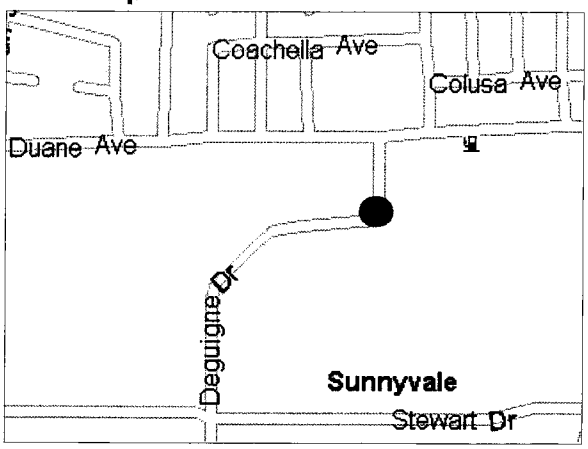
Average Dry Weather Flow: 268 *gpm*
Peak Measured Flow: 367 *gpm*

Sites upstream from this site: Site 7

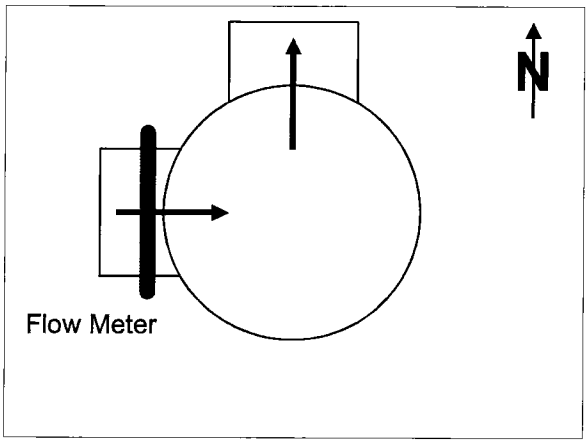
Sanitary sewer map:



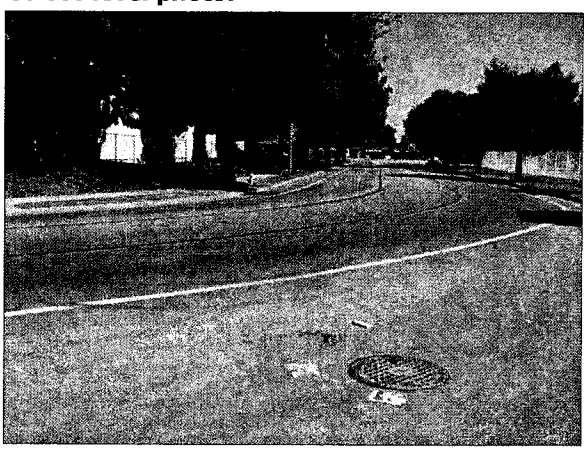
Street map:



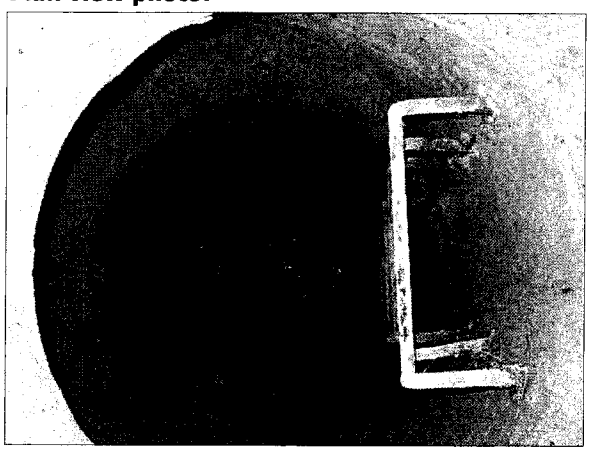
Flow sketch:



Street-level photo:



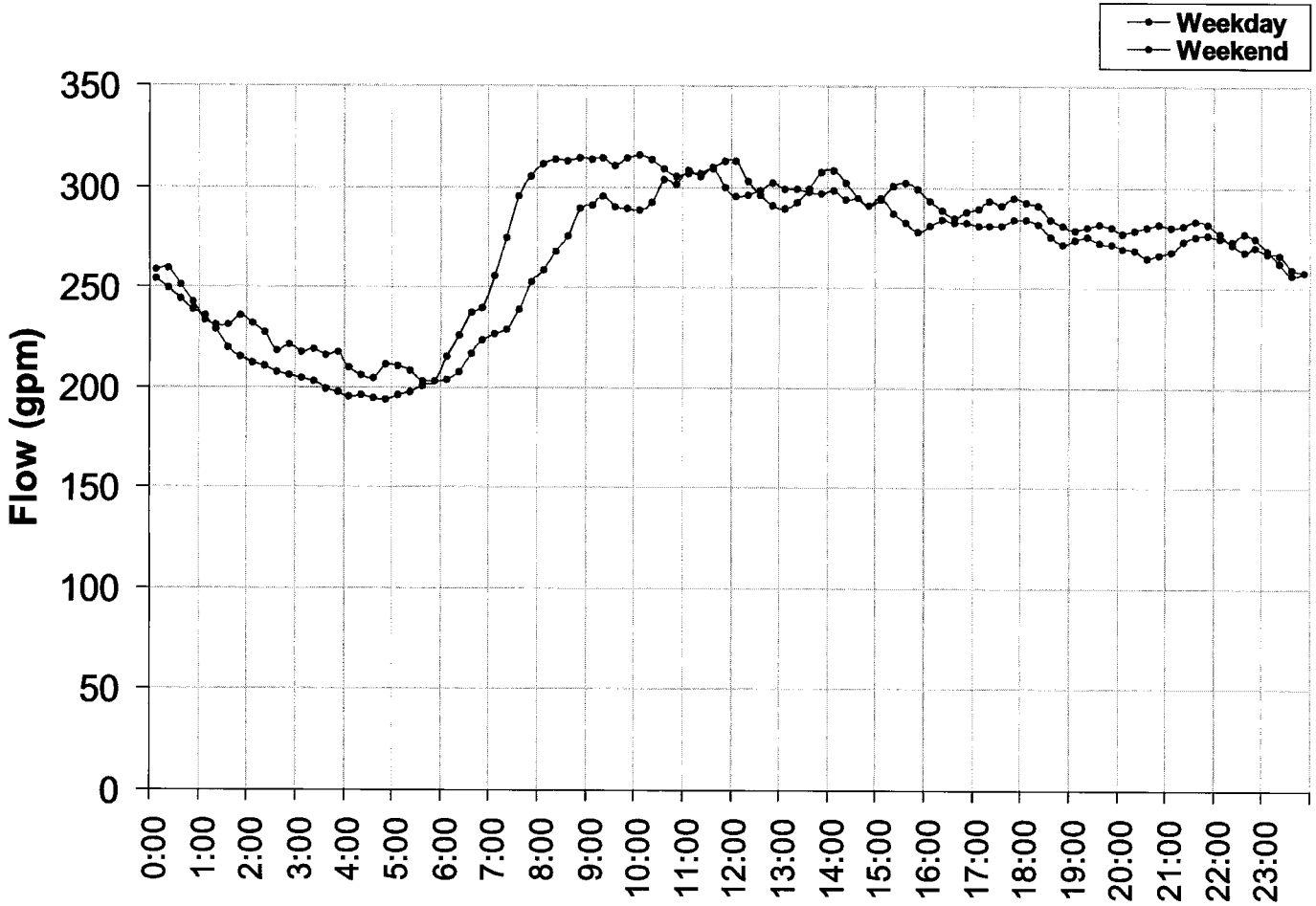
Plan view photo:



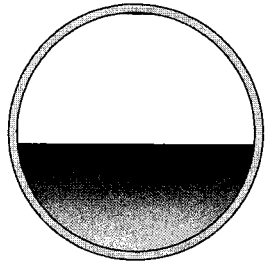
V&A

Average Dry Weather Flow

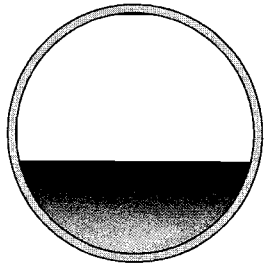
Monitoring Site:
Site 6



Peak Measured Flow:
367 *gpm*



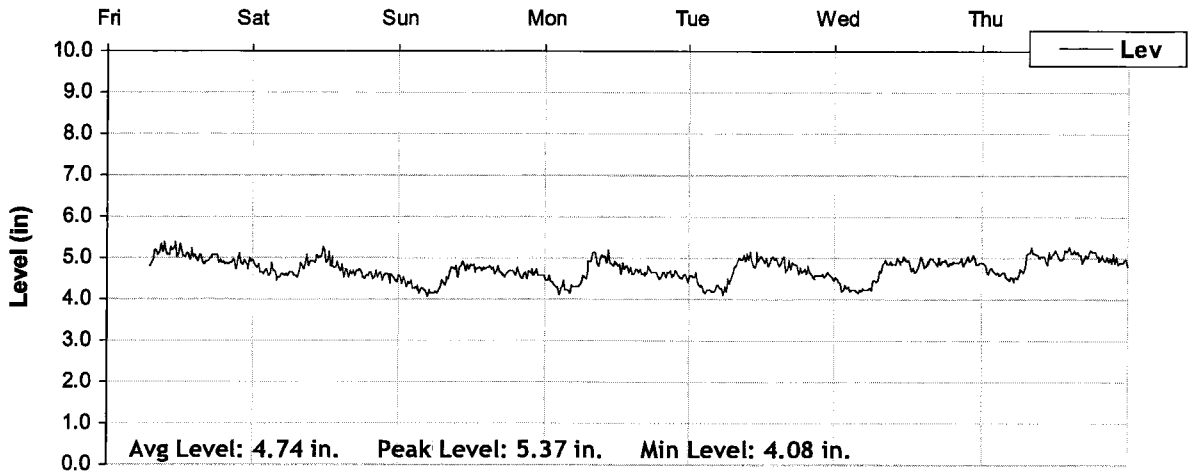
Average Dry Weather Flow:
268 *gpm*

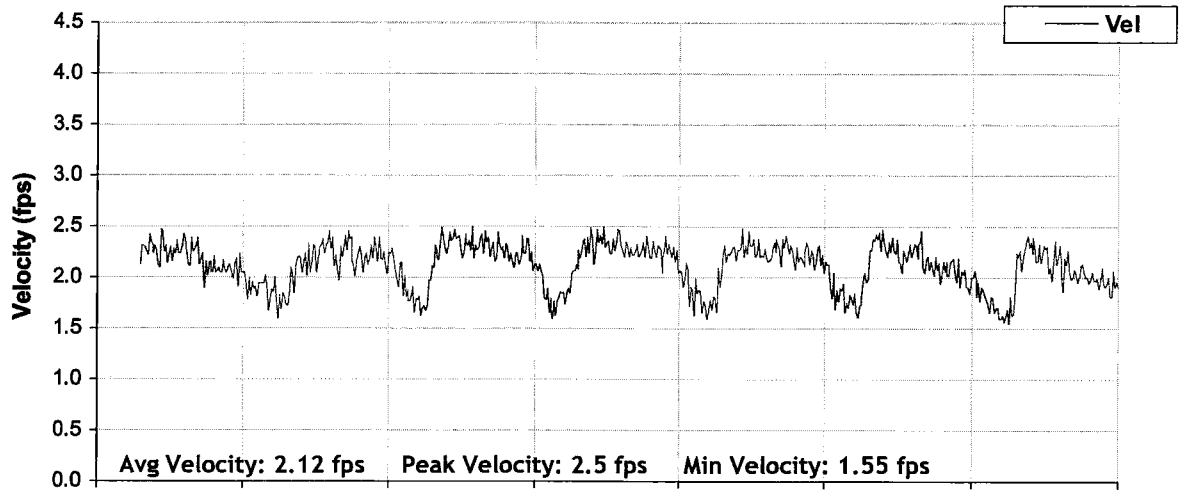


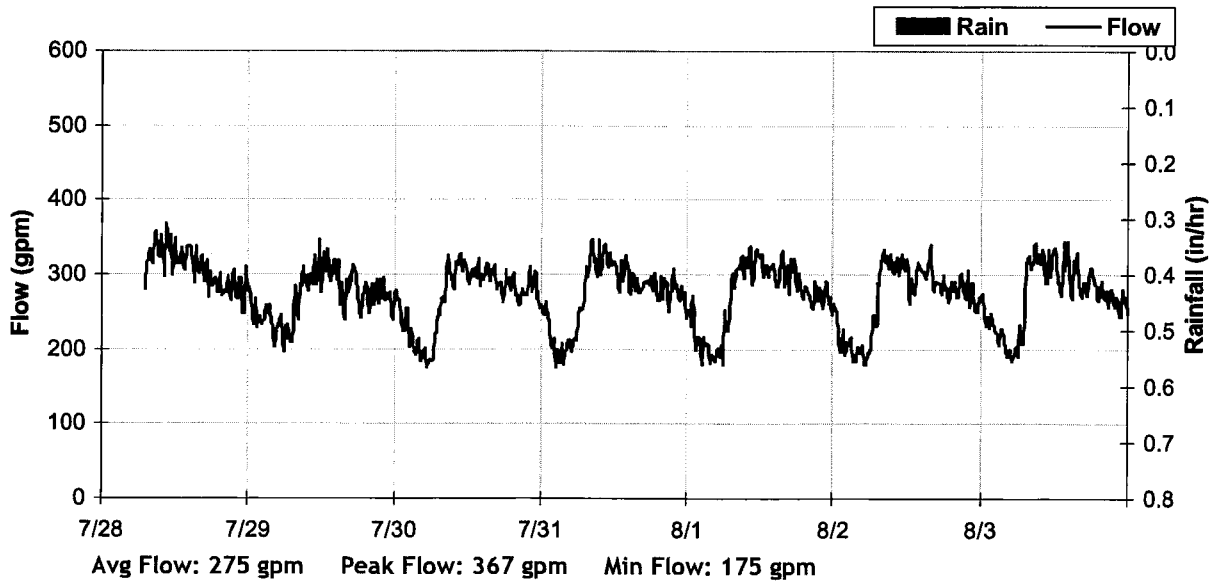
V&A

Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 6



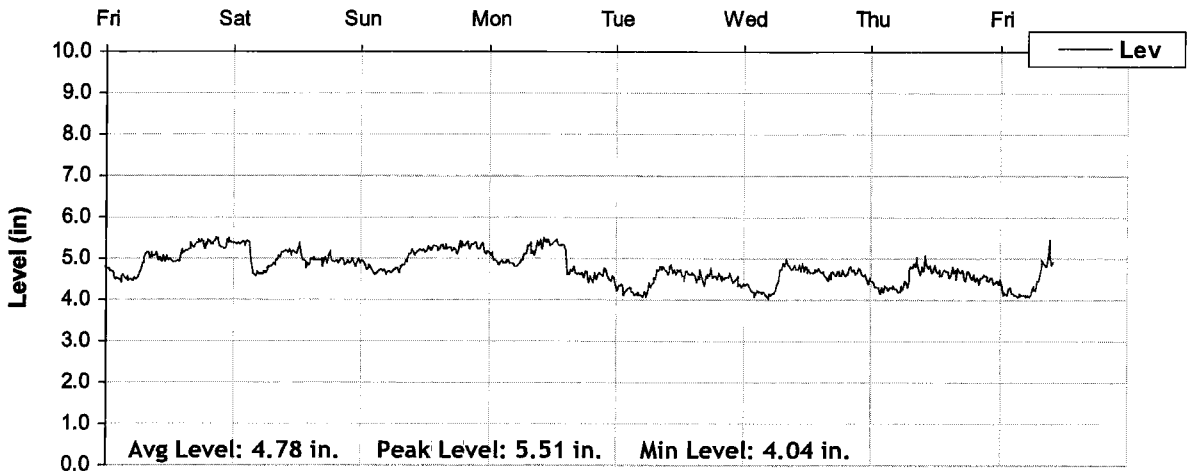


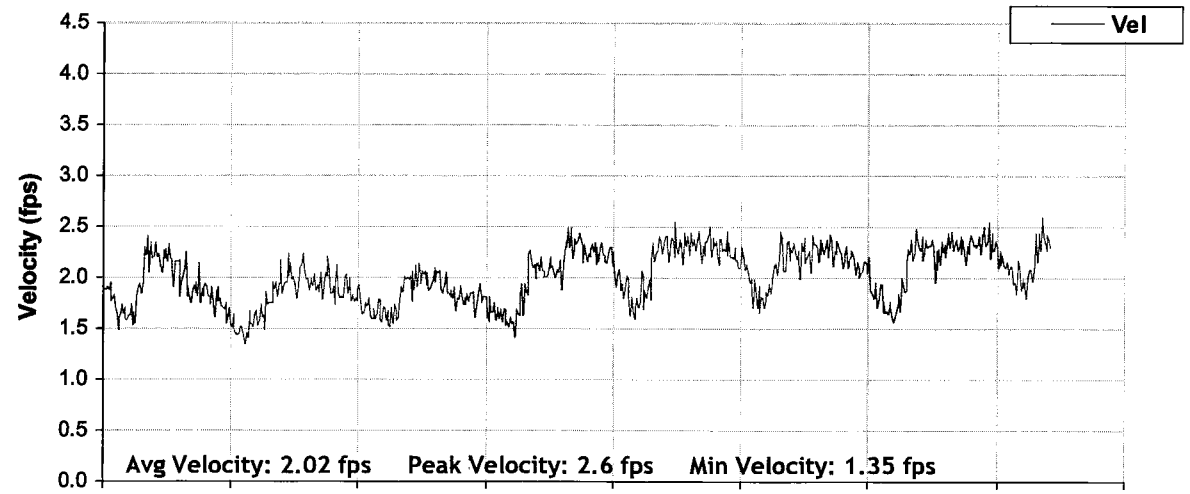


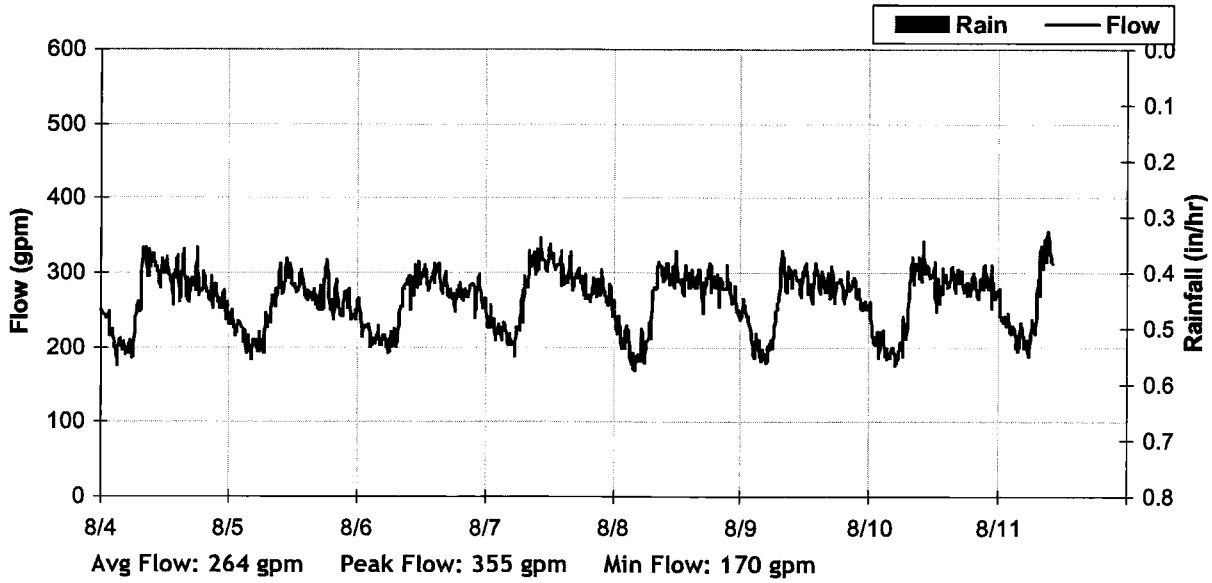
V&A

Level, Velocity and Flow
From 8/4/2006 to 8/11/2006

Monitoring Site:
Site 6







V&A

Site Information Report

Monitoring Site: Site 7

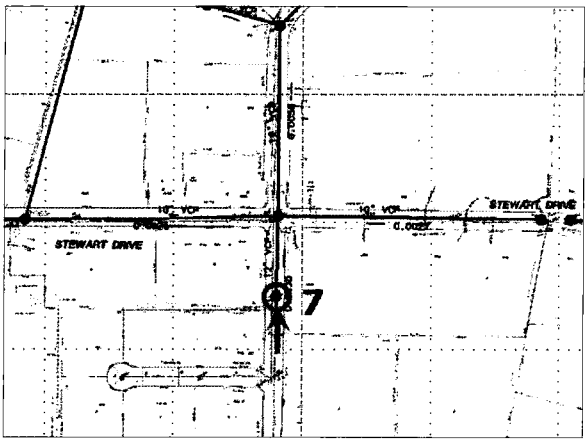
Location: Center turn lane of De Guigne Drive south of Stewart Drive
Traffic: Little

Diameter: 12 inches
Pipe material: VCP

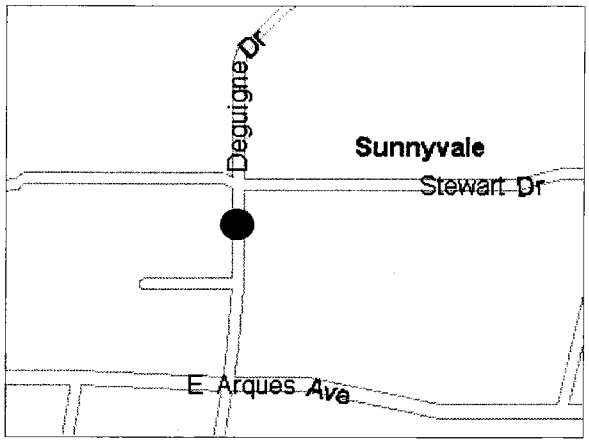
Average Dry Weather Flow: 13 *gpm*
Peak Measured Flow: 44 *gpm*

Sites upstream from this site: None

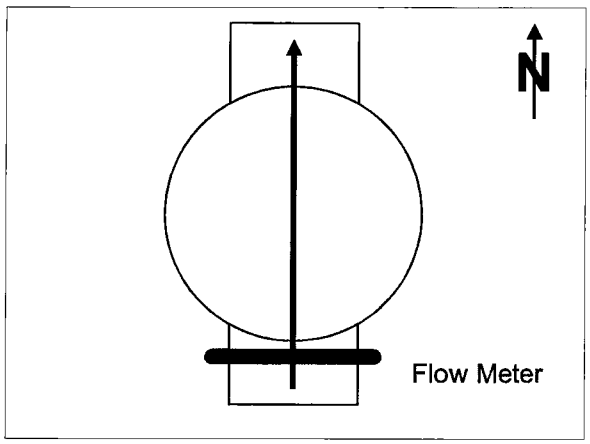
Sanitary sewer map:



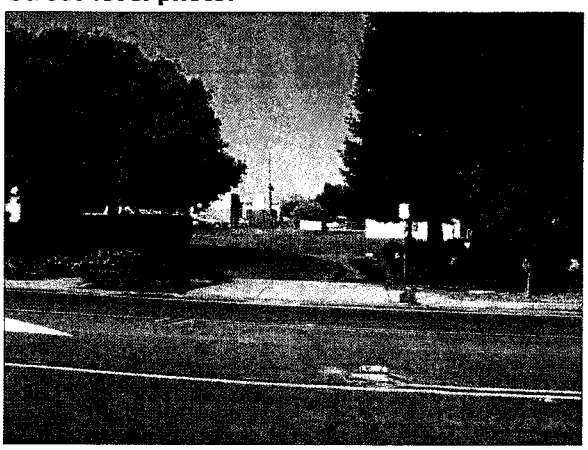
Street map:



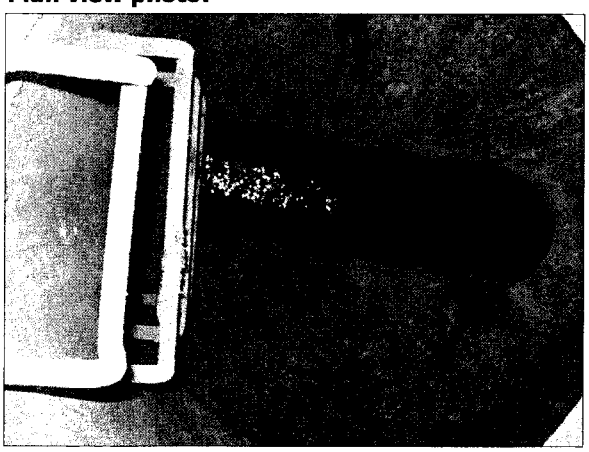
Flow sketch:



Street-level photo:



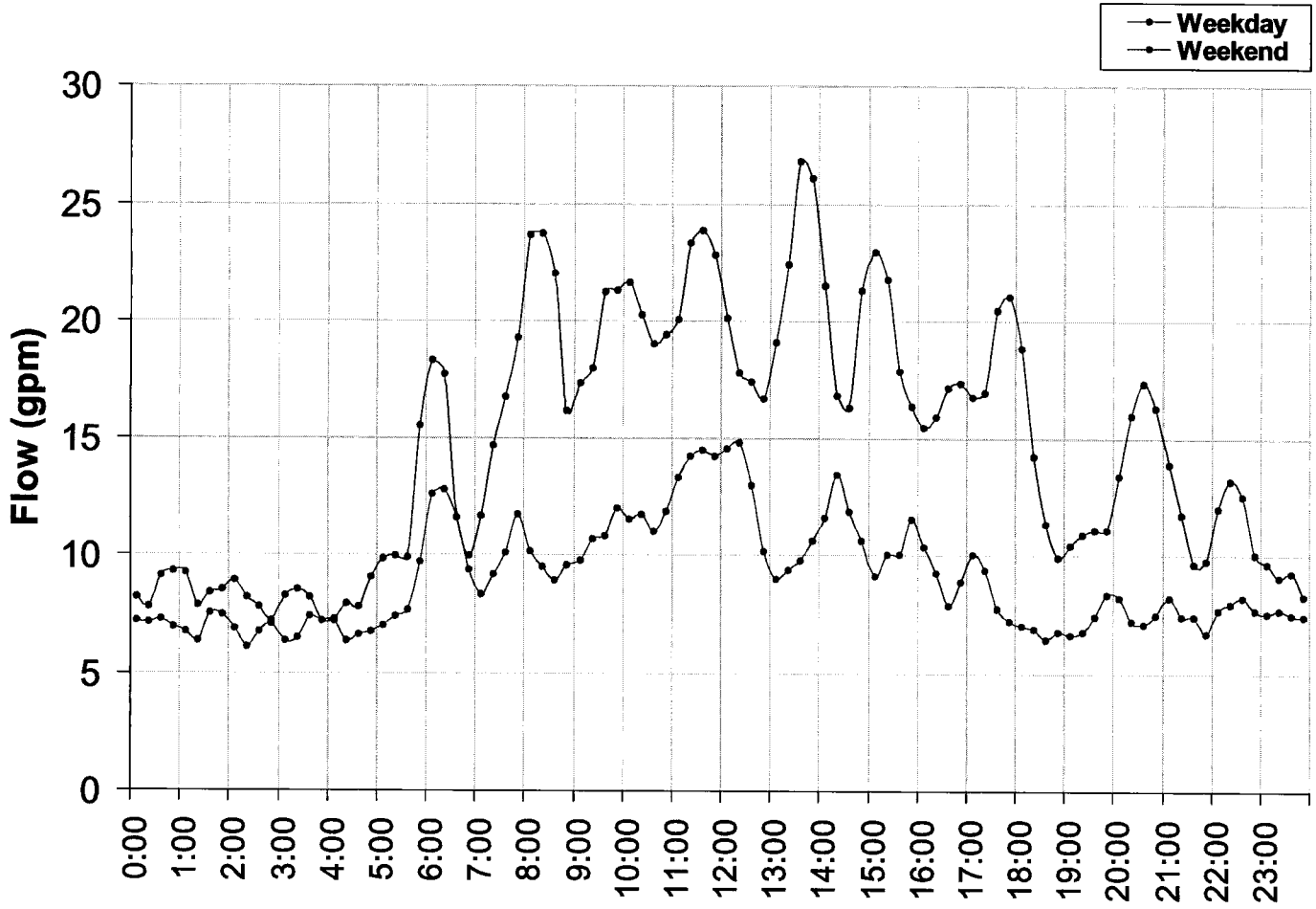
Plan view photo:



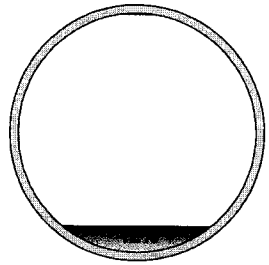
V&A

Average Dry Weather Flow

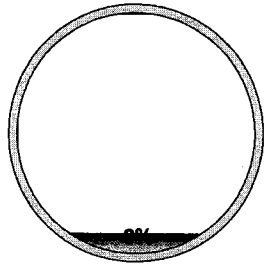
Monitoring Site:
Site 7



Peak Measured Flow:
44 *gpm*



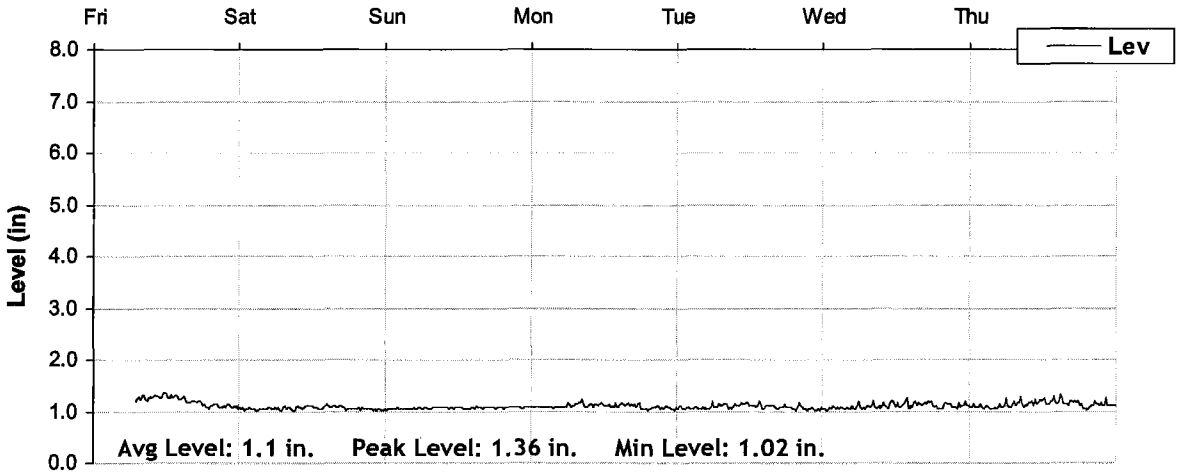
Average Dry Weather Flow:
13 *gpm*

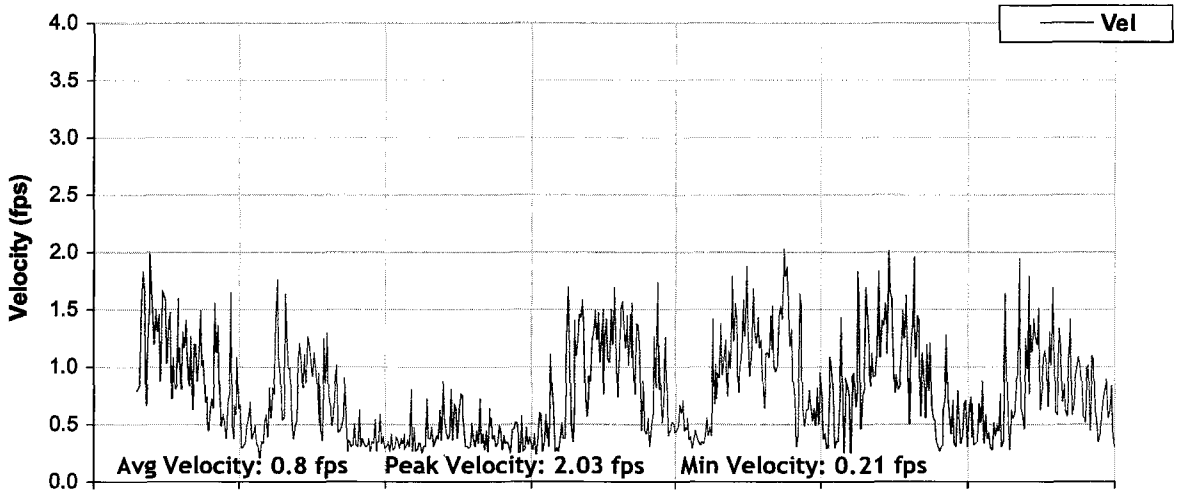


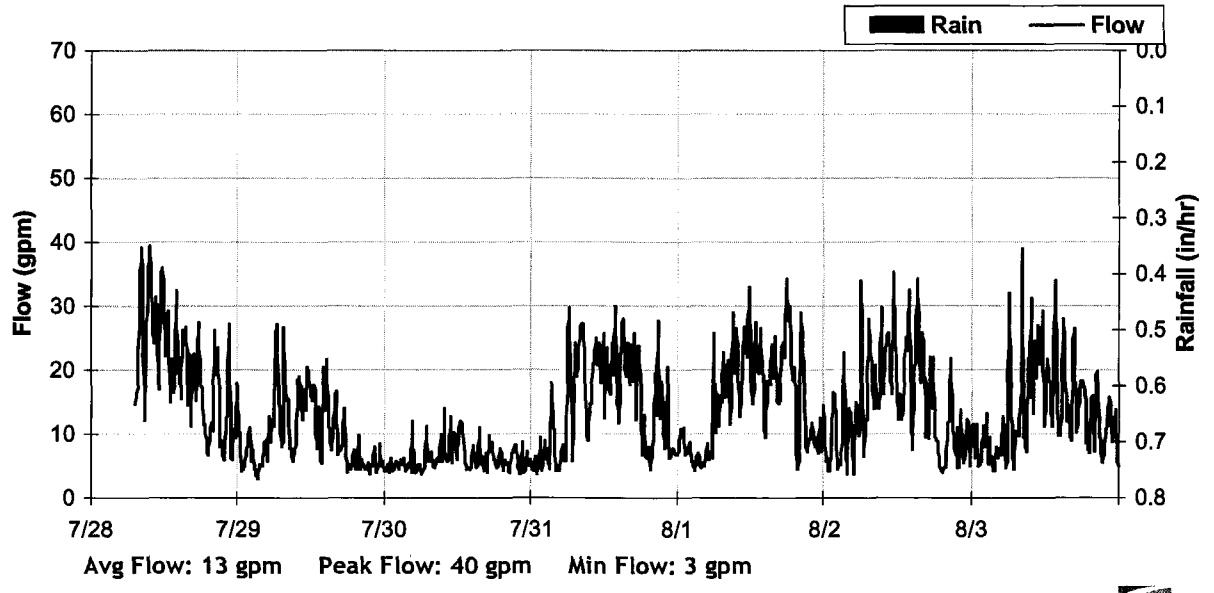
V&A

Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 7



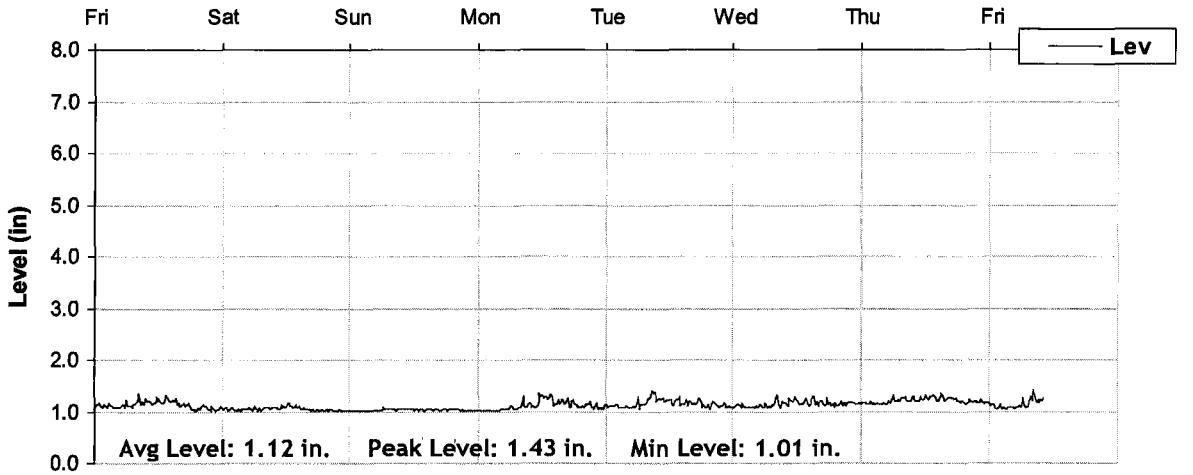


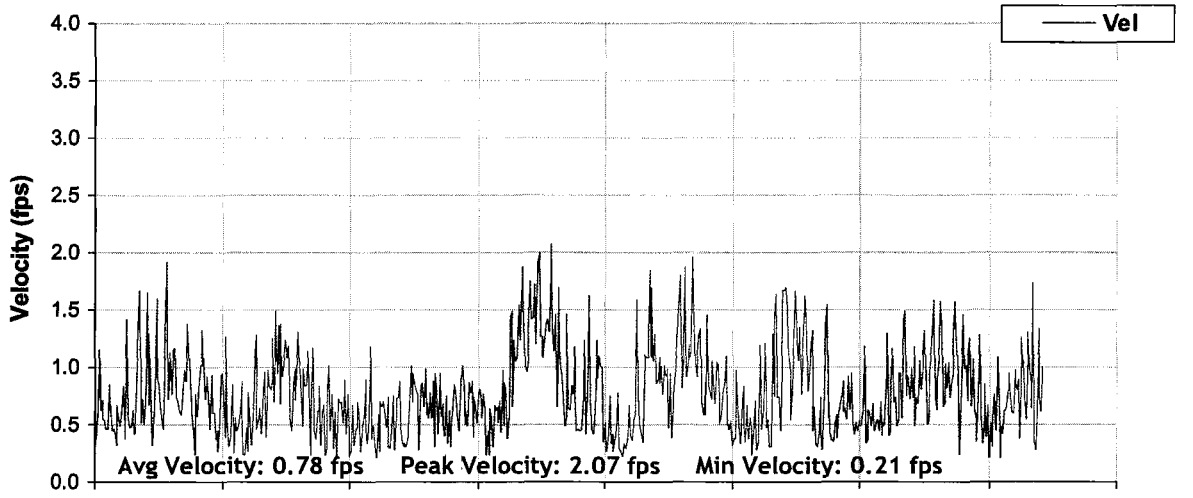


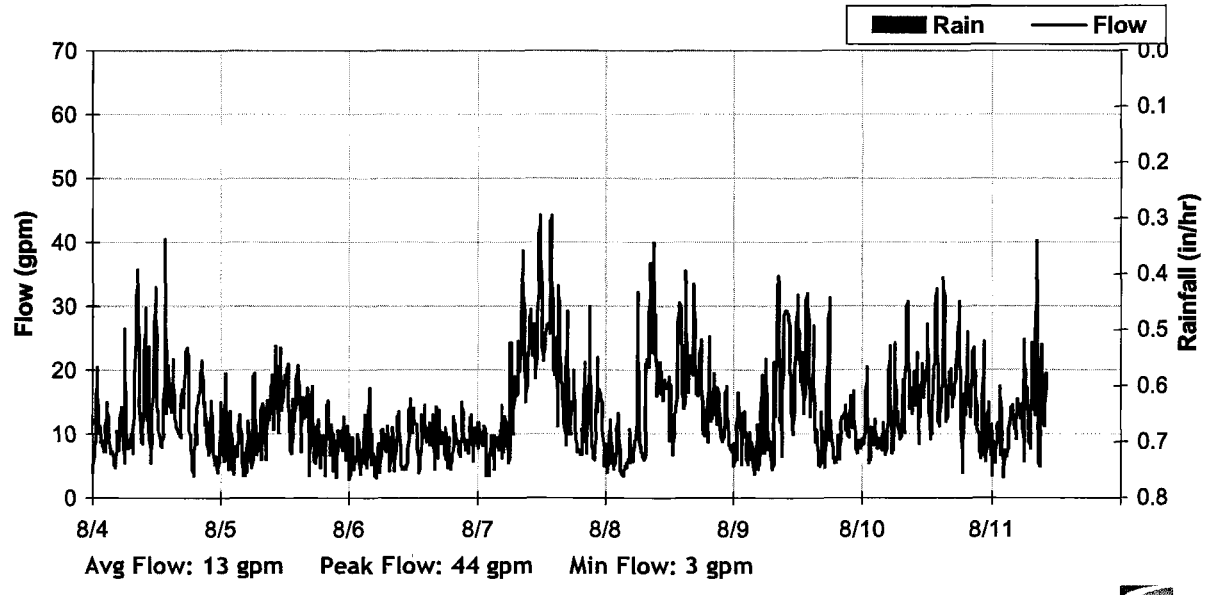
V&A

Level, Velocity and Flow
From 8/4/2006 to 8/11/2006

Monitoring Site:
Site 7







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Site Information Report

Monitoring Site: Site 8

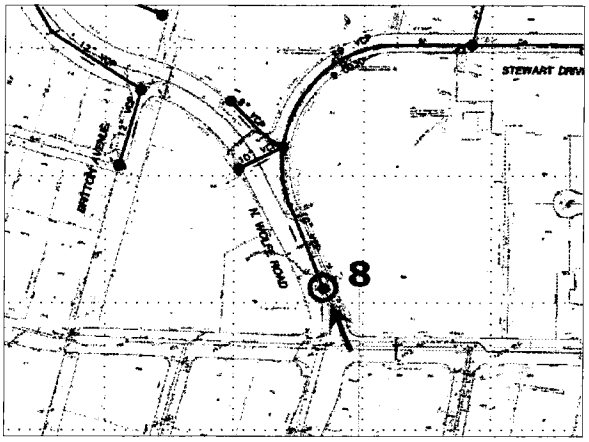
Location: Leftmost northbound lane of North Wolfe Road north of East Arques Road
Traffic: Heavy traffic with a few breaks due to traffic signal

Diameter: 10 inches
Pipe material: VCP

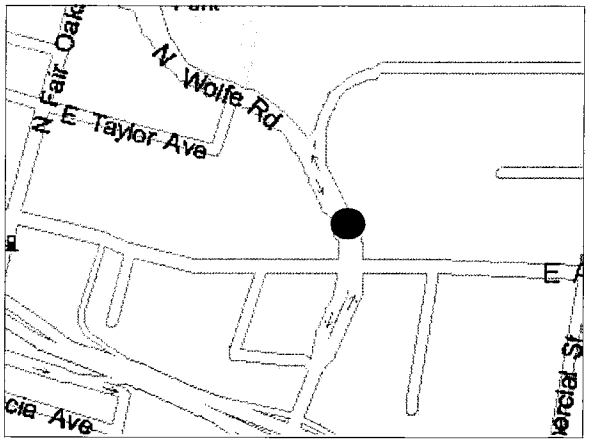
Average Dry Weather Flow: 5 *gpm*
Peak Measured Flow: 11 *gpm*

Sites upstream from this site: None

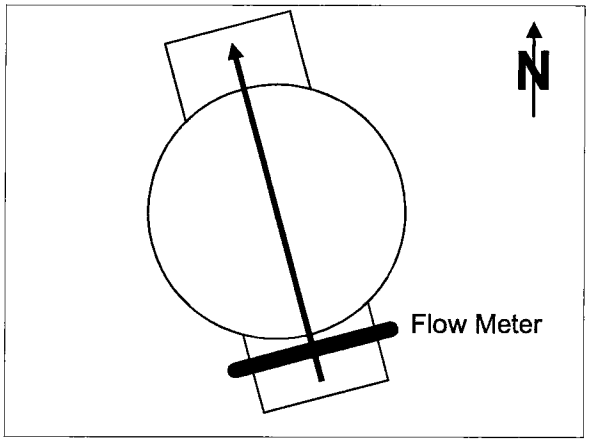
Sanitary sewer map:



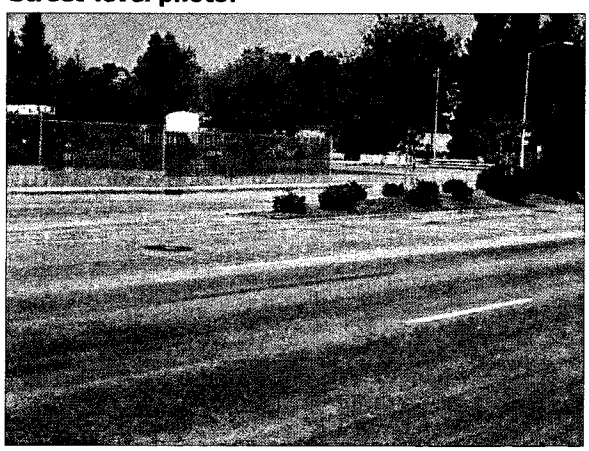
Street map:



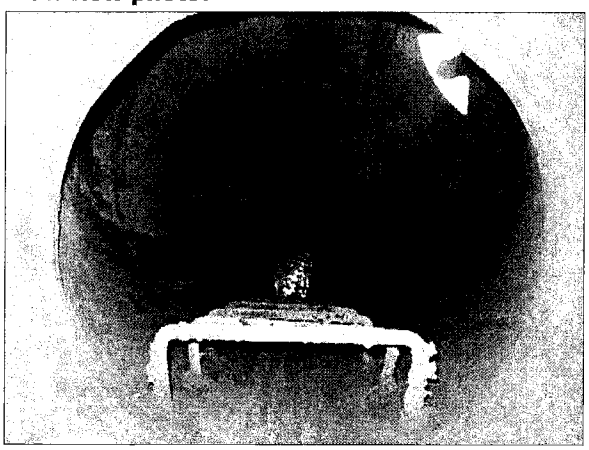
Flow sketch:



Street-level photo:



Plan view photo:



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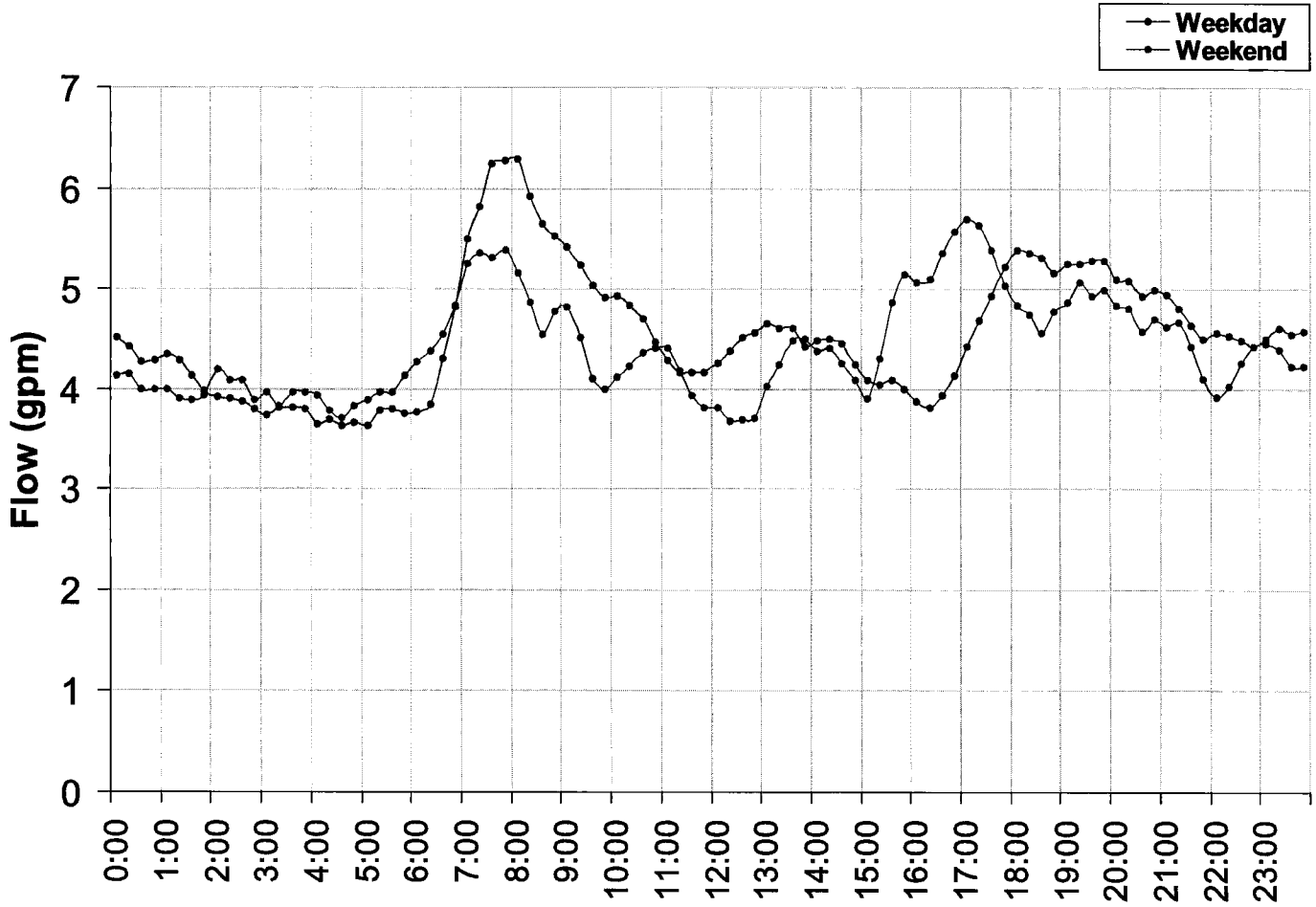
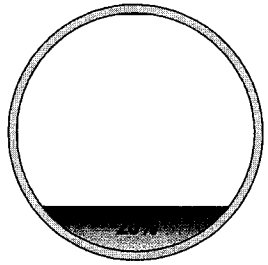
Average Dry Weather Flow

Monitoring Site:
Site 8



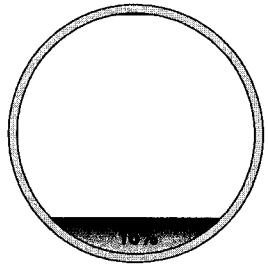
Peak Measured Flow:

11 *gpm*



Average Dry Weather Flow:

5 *gpm*



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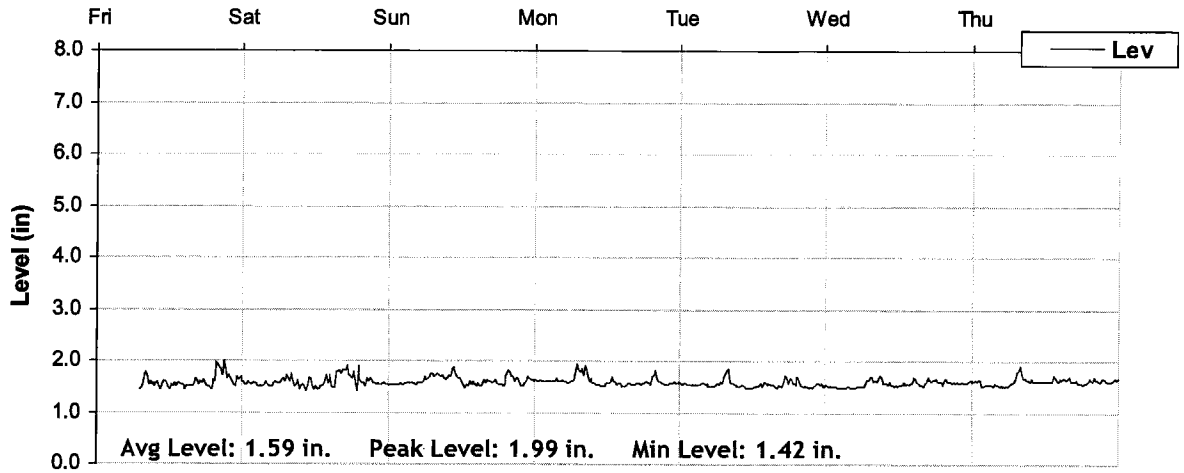
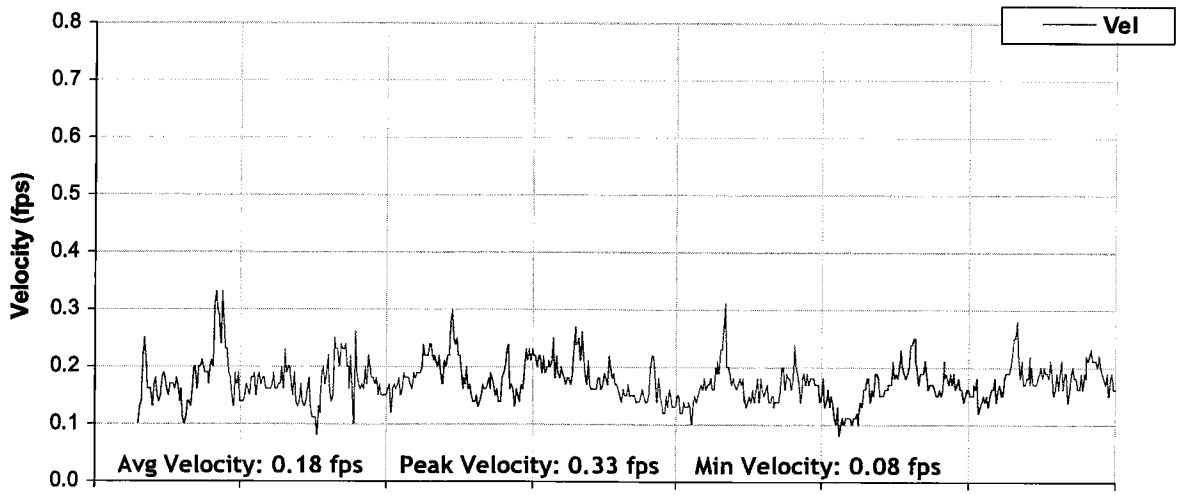
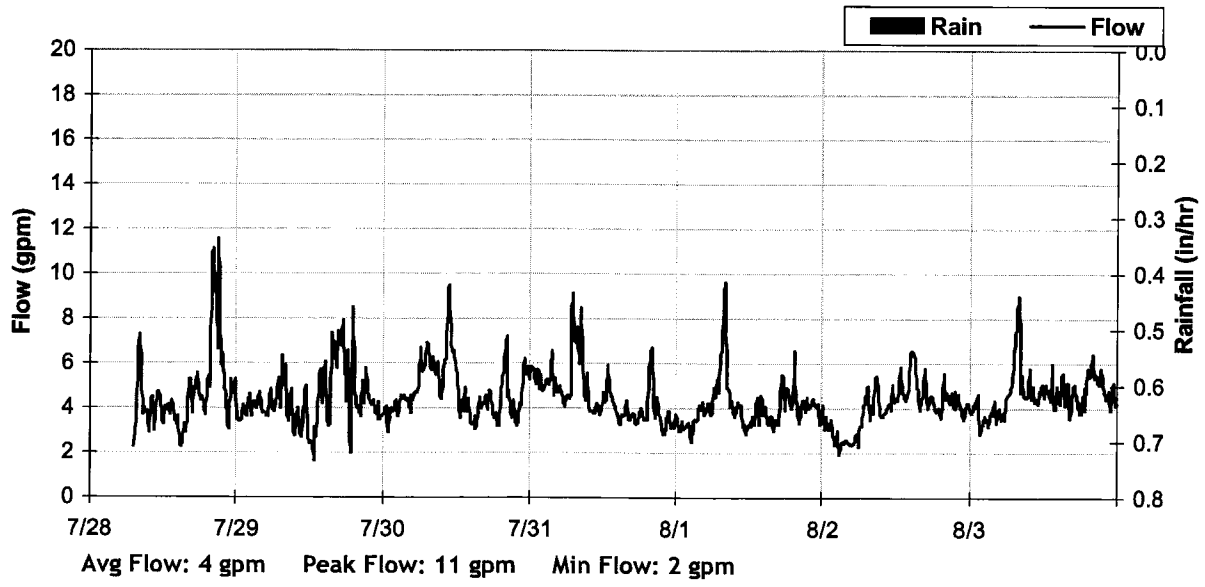
Level, Velocity and Flow
From 7/28/2006 to 8/4/2006

Monitoring Site:
Site 8







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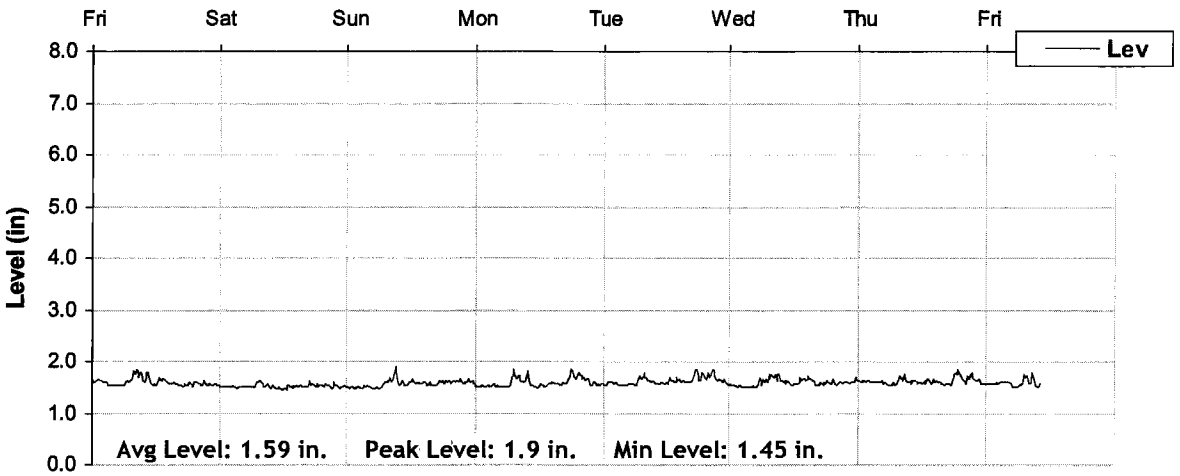
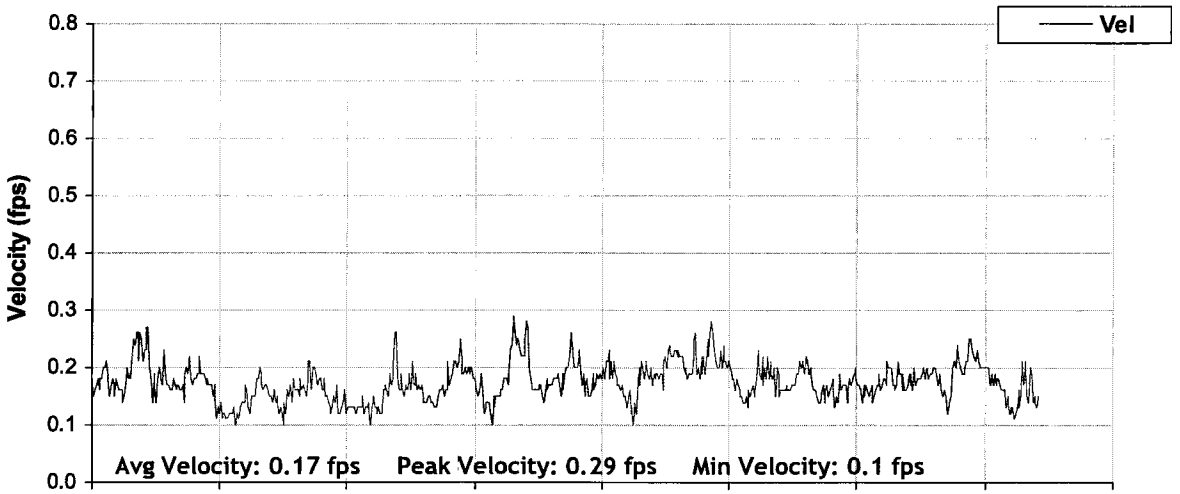
Level, Velocity and Flow

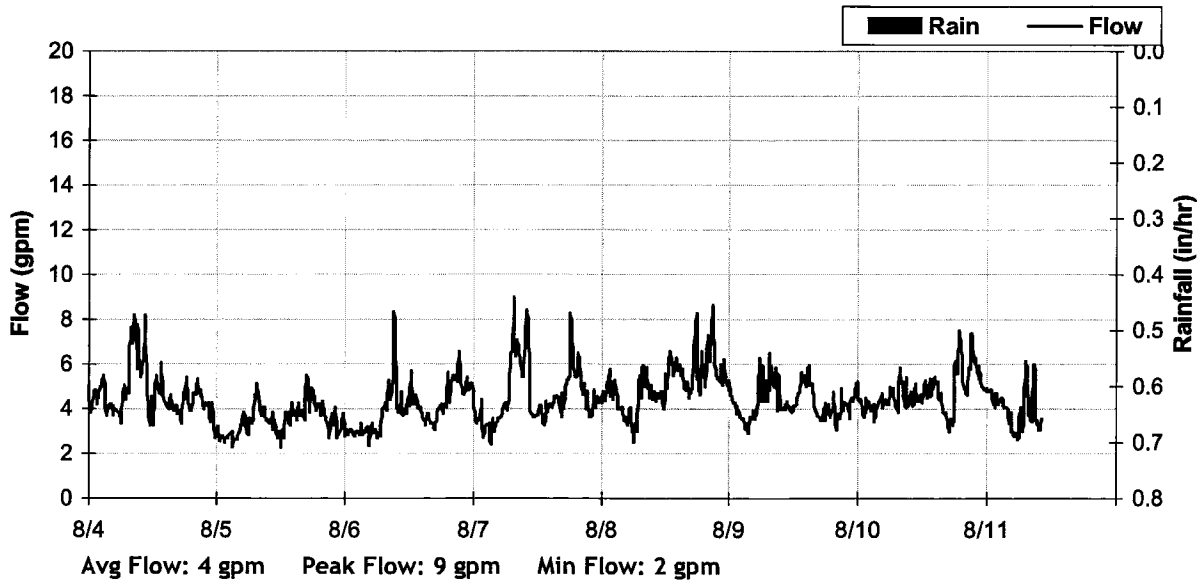
From 8/4/2006 to 8/11/2006

Monitoring Site:

Site 8







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